MURPHY CREEK PROJECT:

WILDLIFE STUDIES

Prepared for:

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B.C. HYDRO

This impact assessment is based on the "Murphy Creek Project Engineering Description" prepared in November 1982. Since that time, ongoing planning and design studies have resulted in some changes that would affect the project description. The principal changes are as follows:

- In-service date has changed from 1993 to 1995.

- Installed capacity has changed from 300 MW to 275 MW.

- Small changes to the design and locations of shoreline protective works.

- Daily reservoir level fluctuations limited to 2.0 m during March, April and May (previously March and April).

The above changes have been incorporated in the report only where they would affect the results of the impact assessment.

STUDY TEAM

This report was prepared for B.C. Hydro & Power Authority as the wildlife component of a series of environmental studies which will collectively form the basis of an Environmental Impact Assessment of the Murphy Creek Project.

The report was prepared by Beak Consultants Limited, Vancouver, and the study team was composed of the following: I. Robertson - Project Manager, Birds; R. Moody and M.J. Comfort - Big Game Animals; A.I. Moody - Big Game Habitats; L.R. Quaife - Furbearers; W.J. Merilees - Birds; D. Day - Drafting; and S. Flaata - Word Processing.

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1.0 SUMMARY

Wildlife studies related to the proposed Murphy Creek Project have provided an outline of the chief wildlife resources of the proposed reservoir and adjacent lands up to an elevation of 500 m. Based on the physical changes anticipated as a result of the project, the following summarizes our chief conclusions regarding wildlife impacts.

1. Deer surveys conducted during this study indicated relatively low numbers of deer wintering below 500 m. Deer numbers based on January and February 1981 surveys were 32 and 48 deer respectively. These results were obtained during an atypically mild winter. Deer numbers based on January and March 1982 surveys were 196 and 20 deer, respectively. These results were obtained during what was considered a normal winter.

2. Discussions with the Trail Wildlife Association lead us to believe that in normal winters the study area provides winter range for 100-200 deer, and possibly as many as 400 during a severe winter.

3. Habitat studies (browse and pellet group surveys) and the literature on deer food habits were used to produce a map outlining winter habitat utilization by ungulates (primarily deer). The categories identified and their areas are: moderate/high - 258 hectares (7%); low/moderate - 710 hectares (20%); low - 1,873 hectares (52%); and altered (i.e. by development) - 776 hectares (21%).

4. Reservoir flooding to 424 m would eliminate the following areas of lowland deer habitat: moderate/high - 8 ha; low/moderate - 37 ha; low - 348 ha; and altered 6 ha. This represents an estimated lost carrying capacity for 5 deer or 18 deer depending on the habitat capability scheme employed.

5. No impacts on elk were identified.

6. Construction activities would result in disruption at various designated work and spoil areas and disturb wildlife habitats temporarily at the till and

aggregate borrow sites. Reclamation/revegetation at these sites would reduce these to short term impacts.

7. Impacts on hunting appear to be minor.

8. Furbearer numbers and trapping effort in the study area appear to be minimal. Holders of registered traplines in the study area direct their main trapping efforts elsewhere on their lines.

9. Negative impacts on aquatic furbearers would be minor or less. The impact on trapping would be insignificant.

10. In a regional context numbers of aquatic birds are low, but the study area has at least two species, common merganser and spotted sandpiper, which prefer river habitats. These species would experience the greatest decline.

11. Negative impacts to other aquatic birds would be non-existant to minor.

12. The chief upland game species in the study area is ruffed grouse. Ruffed grouse are found along the benches above the river, most of which are above the planned reservoir level. Impacts though negative are predicted to be minor.

13. One traditional osprey nest would be removed and another would be threatened by higher water levels. Should these events occur without successful renesting, artificial nest structures should be considered.

14. Operating Regime 2, with an estimated reservoir drawdown occurring infrequently (once in 35 years), offers the best chance for marsh habitat development around the reservoir perimeter. It is preferred to operating Regime 1 (annual February to May drawdown). Morainal deposits in the Castlegar area would limit wetland creation as a mitigation or habitat enhancement strategy.

15. The flooding of the oxbow below and east of the Selkirk College campus creates the potential to establish an island for nesting Canada geese and ducks under operating Regime 2.

16. To compensate for loss of deer habitats, habitat improvement programs are recommended for nearby areas (Deer Park on Arrow Lakes Reservoir and Balfour gravel pit above Robson represent potential sites for such programs); Champion Creek, and terraces above Murphy Creek.

17. Initial reservoir flooding impacts could be reduced by timing the flooding for the late July to mid-October period.

2.0 INTRODUCTION

The Columbia River valley between Castlegar and Trail is the proposed site of the Murphy Creek Dam and reservoir (Figure 1). As part of its environmental evaluation of this project, B.C. Hydro contracted Beak Consultants Ltd. to undertake wildlife studies. According to the Terms of Reference (Appendix 1), these studies represent one component in a series which will provide data for an environmental impact statement.

The specific objectives of this study are to:

i) provide an inventory of wildlife resources of the study area under categories of big game, furbearers and aquatic and terrestrial birds;
ii) evaluate and identify general impacts of the proposed project, and specify resource losses and gains; and
iii) propose mitigation measures designed to avoid or reduce negative impacts which could result from the project.

The study area has been formally defined in the Terms of Reference as "all lands on either side of the Columbia River[1] from the axis of the proposed dam in the vicinity of Oasis upstream to the Hugh Keenleyside Dam on the Columbia River, and to the Brilliant Dam on the Kootenay River up to an elevation of 500 m" (Figure 1). In this report the term "study area" refers specifically to this definition. Several extensions to this study area have been added. First, B.C. Hydro identified five potential till deposit sites, and as requested, BEAK included the three west side deposits in the study area for wildlife. Subsequently, till material was found only in the Murphy Creek area. Second, field data on aquatic birds were collected on the lower portion of the Arrow Lakes Reservoir and the Brilliant Dam reservoir for comparative purposes. In general, the study team recognized that the upper study area limit of 500 m was arbitrary. As a consequence, though field data were not collected above this elevation except at

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1 Unless otherwise stated, all references to the Columbia River refer only to the study area section.

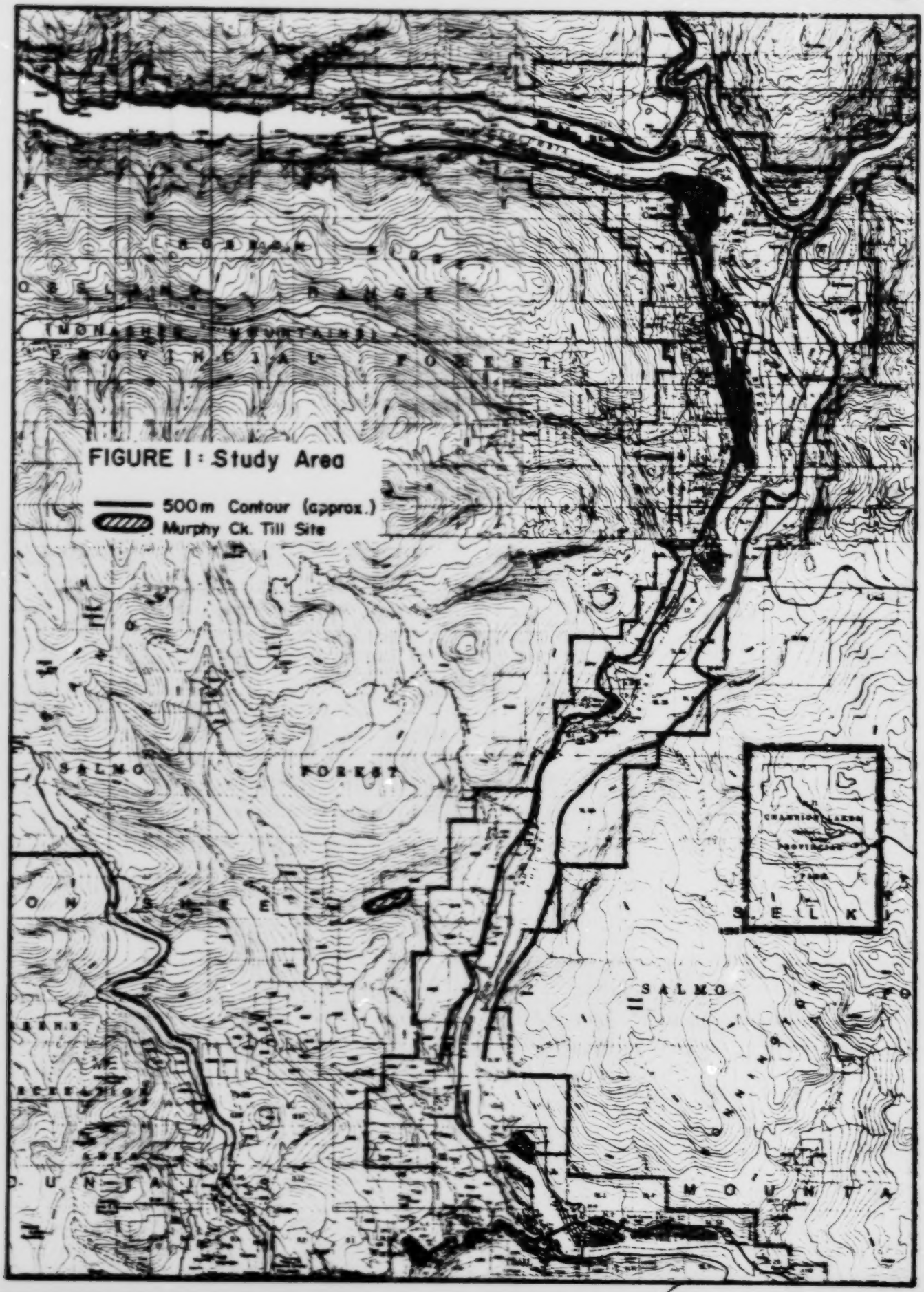


FIGURE I: Study Area
500m Contour (approx.)
Murphy Ck. Till Site
SALMO
FOREST
SALMO
SELKIRK

till sites, the perspective included the entire valley and to a lesser extent the entire region. This strategy was particularly relevant in the assessment of deer.

This report is organized in the following sequence. Study design (3.0) outlines the inventory and environmental assessment strategies of the different study components. The inventory of wildlife resources (4.0) presents the main data collected for this report. Project impacts (5.0) review the main project characteristics and related physical impacts, and from this basis potential wildlife impacts are discussed and evaluated. Mitigation, environmental enhancement opportunities and compensation are discussed in Section 6.0.

3.0 STUDY DESIGN

The study design varied with the different wildlife components addressed in this report, but certain general principles were followed. First, existing information, published reports or data in the files of government or individuals were consulted prior to the identification of specific field studies. Second, inventory information was collected in the field, and in some cases this represented the first systematic wildlife surveys in the study area, preliminary though they were. Third, active wildlife groups such as the Trail Wildlife Association and the Castlegar and District Wildlife Association were consulted. The former was able to provide a reasonably accurate historical picture of winter deer numbers, distribution and habitat requirements. The debt to local sources was even greater. Insights into the furbearers of the study area and the related trapping industry beyond harvest records, was provided principally by interviews with the trappers themselves. Regarding aquatic birds, beyond the survey information conducted during this study, the historical perspective and general ornithology of the region was provided by W.J. Merilees, formerly of Selkirk College, Castlegar, utilizing his own records and other records of the West Kootenay Naturalists. Specific methodologies are presented below.

3.1 Big Game

A reconnaissance survey of summer habitats in the study area was undertaken on 19 July 1980 utilizing fixed-wing aircraft. In mid-October, 1980 browse and pellet group plots were sampled in representative habitats of the study area; the methods employed are described in Section 4.1.3.

Aerial surveys were conducted on January 17 and February 16, 1981; and January 4 and March 18, 1982. The surveys were flown in a Bell 206 (Jet Ranger). Ground speed during the surveys was 65 -80 km/h, and the elevation was approximately 65 m. Two observers, one on either side of the helicopter, marked observations on topographic charts, and additional information, particularly habitat descriptions, were recorded on tape.

3.2 Furbearers

At the inception of this impact analysis, the specific objective of the furbearer study program was to collect baseline information on the distribution and relative abundance of aquatic and terrestrial furbearers in the region of the proposed development, using available government trapline information, and winter track surveys (for terrestrial furbearers). However, the latter objective could not be met directly, because the atypically mild (low snowfall) conditions of the 1980-81 winter precluded meaningful track surveys. Due to this constraint, we depended primarily on fur-harvest records, augmented with information from interviews with trappers from the study area. Furbearer harvest statistics do not necessarily reflect species diversity or relative abundance for a particular area. Current market prices for specific species, combined with varying trapper effort and natural, cyclic fluctuations in many furbearer populations, all influence the trapline harvests. Therefore, data collected from this source must be interpreted with this provision in mind.

Trapline locations and harvest statistics were provided by the B.C. Fish & Wildlife Branch, Nelson, B.C. Average annual fur values were provided by Mr. B. Saunders (pers. comm.) from Statistics Canada material. These data were augmented with information gleaned from personal communications with trappers with active traplines in the study area. Interviews were held during the period 26-27 March 1981 with trappers George Worobey, Fred Salekin and Gunnar Erickson. Mr. Jack Killough, who had been ill during initial trapper interviews, was contacted by telephone, 27 May.

3.3 Aquatic Birds

On four occasions, May 30 and October 10, 1980, and February 25 and March 26, 1981, surveys of aquatic birds were made. Results of the February 25 survey were lost in a fire on the BEAK premises on 22 March, and the March 26 survey was an attempt to replace the earlier results.

The surveys utilized a Bell 206 (Jet Ranger) and followed the Columbia River at an elevation of 50 m from Oasis upstream to the Hugh Keenleyside Dam and the Brilliant Dam. This provided coverage of the formal study area. In order to help predict the changes to the aquatic bird community, subsequent to the project, these surveys were continued into the adjacent reservoirs upstream. Above the Brilliant Dam the reservoir was surveyed as far as the Slocan pool. Above the Hugh Keenleyside Dam the surveys continued as far as Deer Park. Ground speed during these surveys was 65-75 km/h, except when large aggregations were encountered, at which time the helicopter circled until specific identifications and accurate counts could be completed.

4.0 INVENTORY OF WILDLIFE RESOURCES

4.1 Big Game Animals

To date, there have been no published accounts of big game animals or their associated habitats on the study area. As a result, discussion of these animals and their habitat requirements draws heavily upon the available literature for similar areas, the results of our field studies conducted on the study area, information acquired from locally knowledgeable individuals, as well as more generalized published accounts (Banfield, 1974; Cowan and Guiguet, 1965).

Mule deer (Odocoileus hemionus) and white-tailed deer (O. virginianus) are the most common species of big game animals between Trail and the Hugh Keenleyside Dam. Elk (Cervus canadensis) are present in small numbers. Black bear (Ursus americanus) and cougar (Felis concolor) also occur in the area, the former being much more numerous. Moose (Alces alces) are infrequent visitors to the study area. In addition, mountain goats (Oreamnos americanus) occur in low numbers in isolated pockets of suitable habitat near the northern portions of the area.

4.1.1 Habitat Characteristics

The climate of the Castlegar area is mildly continental, characterized by hot dry summers and cold winters. The daily maxima in June and July range between 20 to 32°C. Summer temperatures are strongly dependent on elevation. Winters are cold, the temperatures and snowfalls are variable, governed in part by the presence or absence of Arctic air masses. Temperatures can, as a result, be very low. The coldest recorded temperature at Castlegar was -30.6°C. January is the coldest and windiest month; average daily maxima are -1.1°C, minima are -6.5°C. In January winds average about 10 kilometers per hour, however winds from the north northwest have a particularly high average speed of 19.2 km/h (J. Emslie, B.C. Hydro, pers. comm.). These cold temperatures and high winds impose high energy requirements for deer at a time when forage quality is limited.

During winter, temperatures are not as elevation dependent as they are in summer, however snowfall is. Heavy snowpacks accumulate at the middle and upper elevations. At Castlegar the mean annual precipitation is 719.0 mm of which 38% falls as snow primarily between November and March[1]. The greatest monthly snowfalls (over 100 cm) in the study area have occurred in early winter (November to December); however, year to year variability is great (Figure 2). This abundance of snow in early winter is expected to be a major feature in inducing deer movements from summer to winter range. Snow depths were measured during January 1982. Results are shown in Table 1.

TABLE 1: Snow Depths at Four Sites in the Murphy Creek Study Area (locations shown on Figure 7)

Location	Snow Depth	Location	Elevation (feet)	Aspect
A	35 cm	Champion Creek fan	1,500	west
B	31 cm	Ball Park	1,450	east
C	38 cm	North of Murphy Creek	1,950	east
D	55 cm	Sullivan Creek	3,000	southeast

The Columbia River valley shows evidence of heavy past glaciation. The valley itself contains several terraces which were formed by fluvio-glacial, as well as fluvial deposits. The major terraces occur at about the 460, 520 and 580 m contours. These terraces consist of sand, gravel and cobbles with minor amounts of silt. The terrace substrates are exposed on the steep (35 to 45 ^{o}) slopes which rise from the valley floor or lower terraces. As these steep slopes are often unstable their vegetative cover is minimal, and their use by wildlife is only as access from one area to another. The lowest terrace (458 m) on the west side of the valley is of limited use to wildlife as much of it is occupied by the towns of Kinnaird, Blueberry Creek and China Creek.

1 Using the standard snowfall-rainfall conversion ratio of 10:1 reveals that slightly more than two meters (205 cm) of snow falls during the average year.

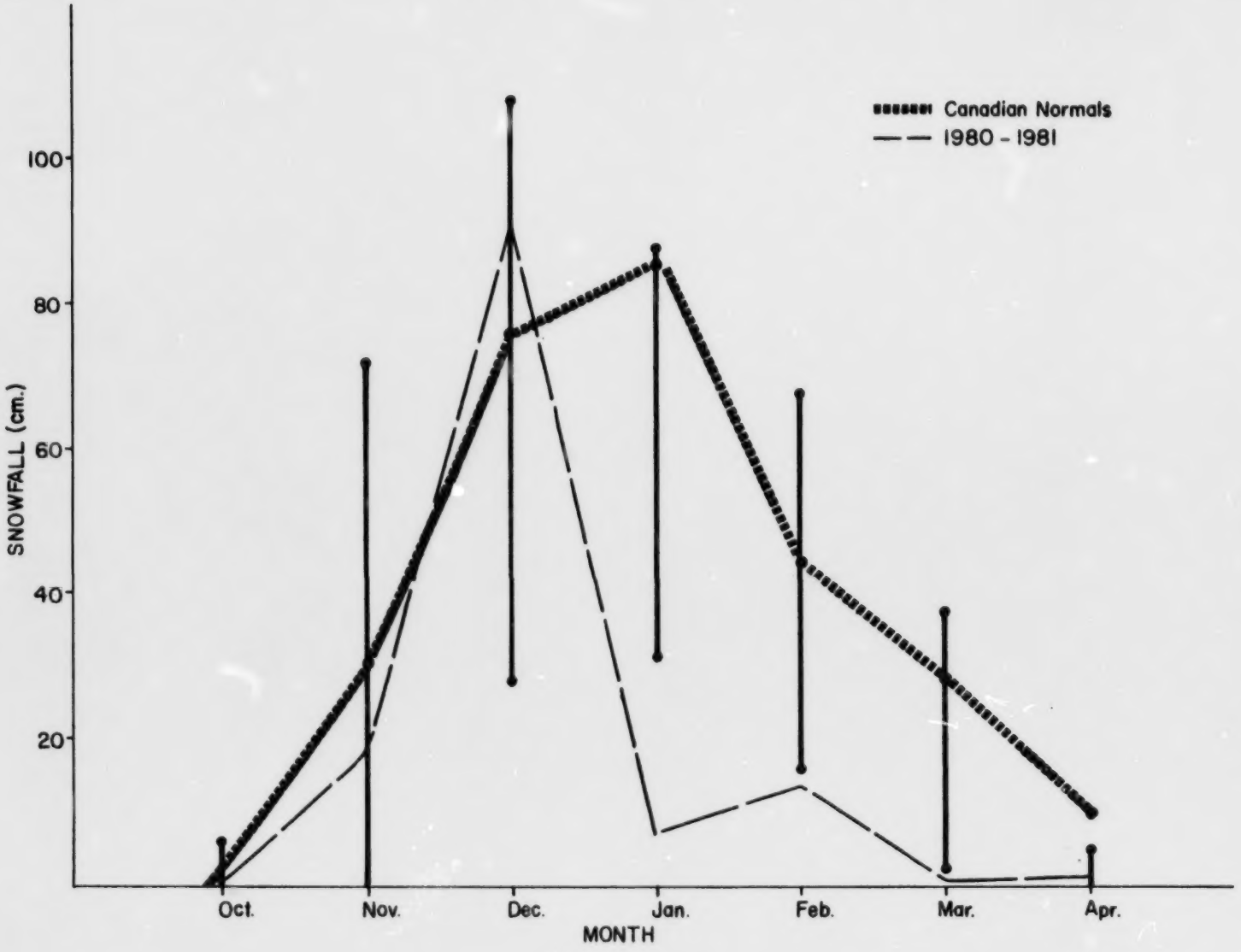


FIGURE 2 : Comparison Of 1980-1981 Snowfall (cm.) To Canadian Normals 1951-1980. (± SD) at Castlegar, B.C.

The soils of the study area are predominantly Orthic Dystric Brunisols which have undergone only moderate development from the original glacial till or glacio-fluvial deposits (Valentine et al., 1978). All of these deposits are moderately or very coarse textured and rapidly drained. These substrate characteristics, in concert with climatic restrictions, determine the vegetation of the study area. In an examination of precipitation and evapotranspiration, Van Ryswyck (cited in Hodson, 1971) determined that the Trail area soils had a moisture deficit of 280 mm from June through mid-September. As precipitation and temperature records for Castlegar and Trail are similar, this condition probably exists for most of the study area. The rapidly drained nature of the soils make much of the precipitation unavailable to plants and likely exerts as much influence over the distribution of plants in the study area as do the high evapotranspiration potentials.

The study area is located within the Interior Douglas Fir Zone (Krajina, 1969). The major coniferous species in this zone include Douglas fir, ponderosa pine, lodgepole pine, western white pine, grand fir, larch, white spruce, and cedar[1]. Under natural conditions, ponderosa pine, lodgepole pine, and larch are considered the pioneer tree species in this region (Krajina, 1969). Associated deciduous tree species include trembling aspen, black cottonwood, white birch, and Douglas maple. The conifers are shade tolerant species which can develop under a canopy of deciduous trees. A number of steps in secondary succession have been identified by Bell (1964) as leading to the climax forest of coniferous species. In order of age and development these can be summarized as: 1) deforestation by either burning or logging leading to youthful regeneration characterized by small trees, shrubs and herbs; 2) a hardwood pioneer forest; and 3) a coniferous pioneer forest. A vegetation mosaic (Figure 3) of these various successional stages has evolved in the Columbia River valley as a result of logging, burning and pollution influences from the Trail smelter. The natural vegetation of the Trail area, prior to human influence, was primarily coniferous forest (NRC, 1939). The low elevations and river benches were occupied by Douglas fir, western larch and lodgepole pine. At

1 Common and scientific names of plants are listed in Appendix 2-1.

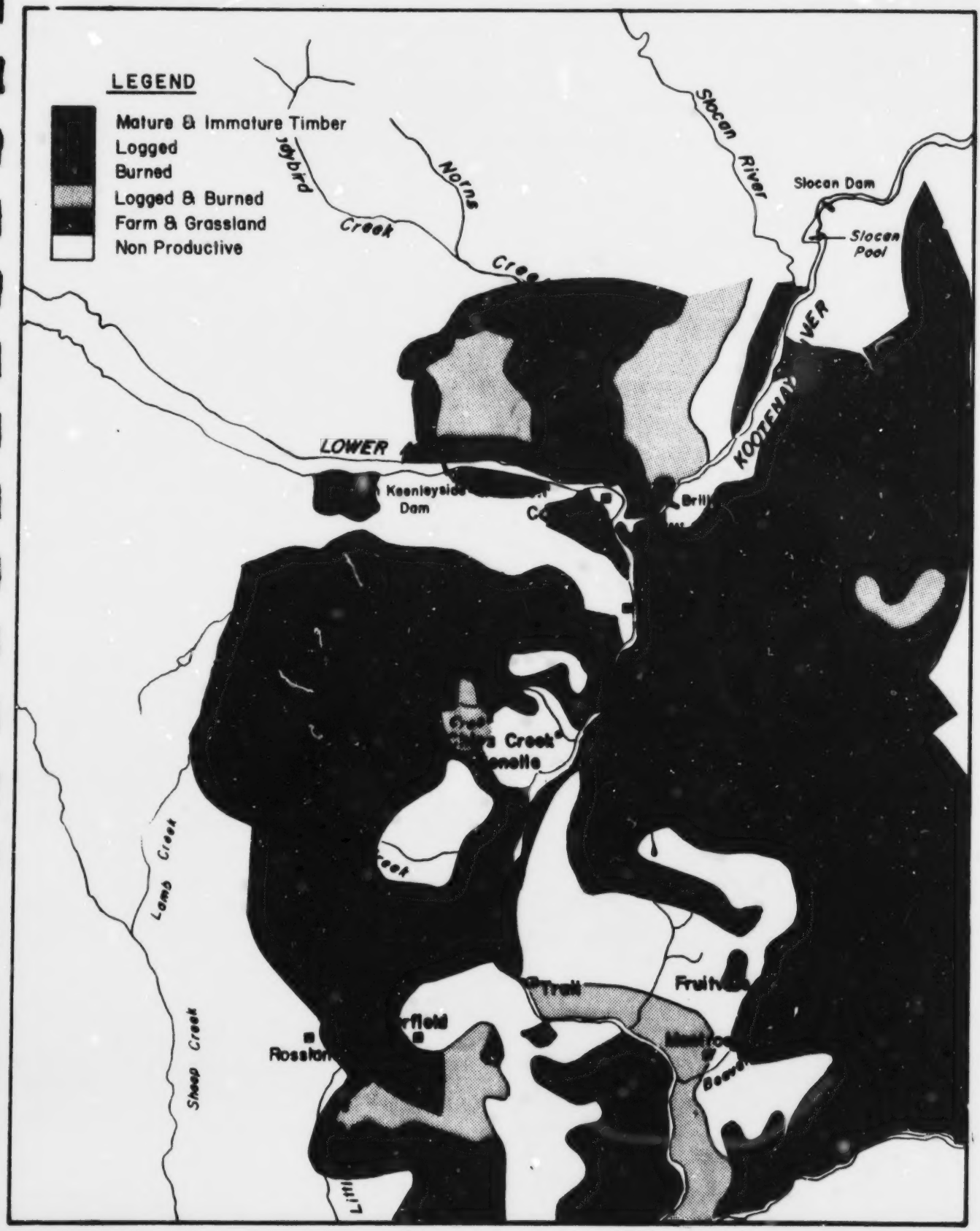


FIGURE 3 : Historical Influences Upon The Vegetation Of The Study Area. (after Archibold 1974, and Hodson 1971)

high elevations and on moist north and east slopes the dominant species were western red cedar, western hemlock and Pacific yew. Dry, rocky sites were habitats for western juniper (USDA, 1955). Descriptions of the former distribution of deciduous tree species of shrubs are lacking in the literature.

The historical development of the Columbia River valley has a direct bearing on the wildlife habitats present in the area today. Settlement of the Columbia valley began to take place rapidly after large ore bodies were discovered in Rossland in 1890. The demand for lumber grew as the local population increased and resulted in the establishment of several sawmills. Lumber was needed for construction and cord wood was needed to supply river boat boilers and to fuel the open pit roasting of ore. By the early 1900's much of the study area had been logged for cord wood and cut lumber (McBride, 1937).

Although fires undoubtedly occurred in the area prior to European settlement the earliest recorded fire was in 1917. After this time fires were frequent and some areas were repeatedly swept by fires.

The smelter at Trail was established in 1896 and has operated continuously since that date. The sulfur dioxide output of the smelter was about 800 tons per month in 1900. During the period 1926 to 1930 the peak outputs averaged 9300 tons per month. As a result, severe vegetation damage ensued throughout the Columbia valley in the vicinity of Trail. Following the decisions of the International Joint Commission the discharge of sulfur dioxide was curtailed to 7100 tons per month in 1931 and was decreased continuously from that date. By 1948 the sulfur dioxide emissions had been reduced to 1400 tons per month (Hodson, 1971).

The effects of the sulfur dioxide from Trail were evident mainly to the south of the smelter, however they extended almost as far north as Castlegar (Figure 4). In the early 1930's the area in the immediate vicinity of Trail was devoid of vegetation and conifers were largely absent. Douglas fir appeared to be most severely affected; a few yellow pine and larch survived. The area between Trail and Castlegar supported limited aspen, willow and some brush, probably redstem ceanothus (McBride, 1937); however much of the region was almost barren. In

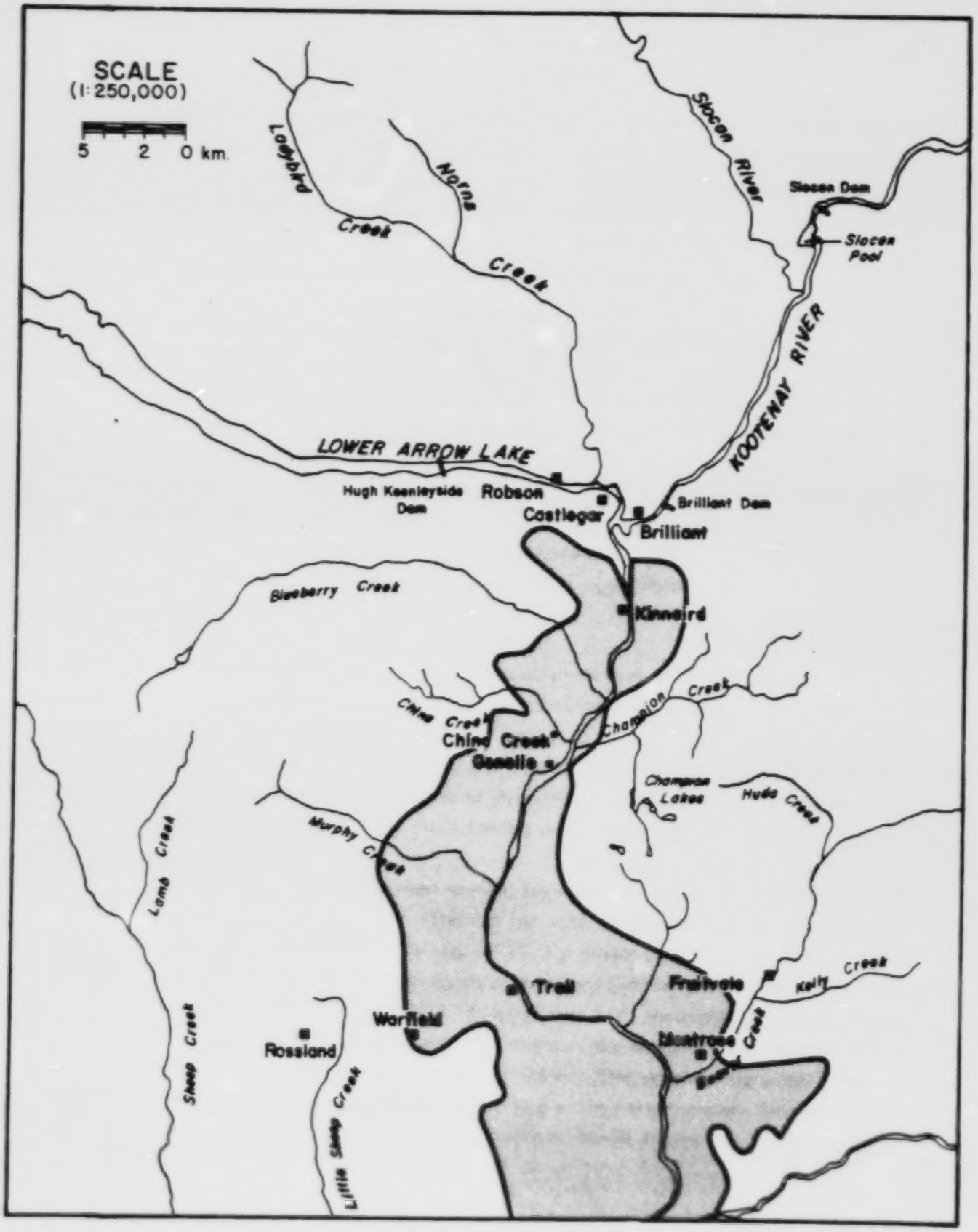


FIGURE 4 : Area affected by sulphur dioxide fumes from Cominco Smelter at Trail.-(after Archibold 1974)

some areas the elimination of vegetation resulted in soil erosion on terraces adjacent to the river. While it is apparent that sulfur dioxide emissions were not the sole factor for eradicating vegetation from much of the area, comparison with neighbouring valleys which have been both logged and burned shows the dramatic results of the SO_2 emissions. The sulfur dioxide emissions certainly affected succession by stressing or eliminating regenerating conifers. This has resulted in some areas having an almost exclusively shrubby vegetation cover and other areas having a slowly regenerating forest canopy dominated by deciduous trees and a dense shrub understory. Such areas provide abundant browse for ungulates provided they are not in a high snowfall location, and nearby forest cover offers shelter.

In addition to the effects of resource use in the study area, historical settlement patterns have resulted in an urbanization of most of the low elevation terraces along the west side and portions of the east side of the Columbia River. This effectively precludes wildlife use of such habitats.

The major restrictions to wildlife abundance in the west Kootenay area have been identified as deep snow in winter and dense forest which lack in quality and quantity of forage plants (CLI, 1971). In the study area, as discussed earlier, the presence of a dense forest canopy is not an issue. During winter, animals move in response to snow fall to areas with low snow and good forage. Such areas are usually located on the low south and west facing slopes of major valleys. The low elevations are subject to lower snowfalls and the south and west exposures receive greater insolation. As a result, low elevations have higher temperatures and less snow. Prevailing winds also help to clear these areas of snow. The shrub vegetation on which deer prefer to forage is usually found in greatest abundance under open forest canopies, which in turn occur on dry southerly exposures.

Mule deer favour winter range with steep south and west facing slopes from valley bottom to elevations of approximately 1,220 meters (CLI, 1971). During summer they use high elevation habitats which contain more nutritious forage species than can be found in the arid valley bottoms. As discussed earlier, a moisture deficit exists in the valley for much of the summer and therefore the more palatable grasses and forbs are in all likelihood unavailable at low elevations in the summer.

Mule deer and white-tailed deer winter ranges often overlap, however white-tailed deer are more restricted by snow conditions. As a result, white-tailed deer are usually confined to elevations below 1,070 meters on south and west facing slopes. The summer distribution of white-tailed deer seldom includes high elevations. Instead, they use valley bottoms and benches (CLI, 1971). These factors are discussed in greater detail in the following sections.

4.1.2 Habitat Utilization and Ungulate Distribution

Both mule deer and white-tailed deer are versatile, wide ranging animals adapted to a variety of habitats and climatic types. Rocky Mountain mule deer are found as far east as Manitoba and as far south as Texas, in a broad variety of habitats. They have a larger range than any other sub-species of mule deer (Wallmo, 1978). White-tailed deer are found throughout most of North America. The northwest subspecies occupies most of British Columbia, portions of Alberta and the northwestern United States as far south as California. White-tailed deer are characterized by their adaptability to a diversity of habitats (Halls, 1978).

Although the foods of deer are variable, in most cases their winter diets fail to meet energy requirements for body maintenance (Wallmo et al., 1977). This means that in favourable seasons deer can afford to be specialists, selecting preferred forages. However, when winter conditions become more severe, and food becomes limiting, due to snow conditions or over-browsing, the animals are forced into a generalist strategy (Nudds, 1980), feeding on whatever plants are available.

Snow depth is one of the most critical factors affecting deer mobility and forage availability. Animals are often forced into a migratory mode, moving from summer to winter ranges (Wallmo, 1978). The seasonal distribution of deer follows a general pattern of high elevations in spring and summer and low elevations in fall and winter (Gilbert et al., 1970). In areas with deep snowpacks at high elevations in winter and low rainfall during the summer, the downward migration occurs in response to forage being covered by snow. The upward migration occurs in response to the low elevation forage drying out by early summer. Animals move to higher elevations to obtain more nutritious forage (Harestad, 1979). Although

winter browse is a conspicuous limiting factor, mule deer diets are extremely variable. Kufeld et al. (1973) found that mule deer consumed a total of 673 species of plants.

The distribution and abundance of deer on their winter ranges is determined by the traditions of the animals, the availability of food and shelter, and climatic constraints such as snow depth and condition, temperature and wind. Heavy snow storms in northern Utah were found to produce mass migration of deer, whereas less severe weather changes resulted in more gradual migrations (Richens, 1967). Returns to summer ranges coincided with the rising temperatures. This could be reversed or delayed by a drop in temperatures, especially when accompanied by wind and snow (Richens, 1967). Migrations could cover as much as 160 km, even bypassing favourable areas on route, to reach historical wintering areas; average migrations were 50 km (Richens, 1967).

The area and utilization of winter range varies according to the severity of winter. Gilbert et al. (1970) found that in Colorado, during severe winters, animals were restricted to less than 3% of their former range. Conversely during mild winters animals are more widely dispersed and were able to take advantage of a variety of foods. Consequently after a mild winter the range is in much better condition than after a severe one. In Oregon Miller (1968) found that during a mild winter, plant species which had been heavily browsed in previous years were only lightly browsed. Deer were able to move to exposed slopes to take advantage of greening grasses.

Ungulate winter range is largely determined by snow depth. Although snow depth is primarily a function of climate, it is also influenced by local features such as elevation, slope, aspect, and forest cover. Loveless (1967) found that during an average winter, 50% of the shrubs on the north aspects and valley bottoms, 20 - 25% on east aspects, and 10-15% on south and west aspects were unavailable as food due to snow cover. He concluded that a snow depth of approximately 30 cm hampered deer movements and 50 cm virtually precluded deer use. Of the 4,000 deer observed by Gilbert et al. (1970), 90% were in areas where the snow depth was less than 50 cm. Deer winter habitats have been found concentrated on south to

west aspects (Klebenow, 1965; Richens, 1967; Loveless, 1967; Martinka, 1967). This selection of aspect results from a complex of factors which combine to result in desirable winter habitat. Snow depths on these aspects tend to be lower than other slopes. This is a result of a high angle of solar interception, heating of the snow pack, and reduction in depth by evaporation and sometimes by compaction of the heavy, wet snow. Because of the high insolation on these slopes the areas tend to be warmer. Loveless (1967) found higher temperatures on these aspects than on surrounding areas. Deer seemed to actively seek sunlight, moving ahead of patches of shadow upslope to remain in sunlight. During cold weather and times of nutritional stress, the warmth of sunshine could considerably ease an animal's energy expenditure. Finally, southern exposures tend to be drier and have different plant communities; shrubs predominate over trees.

Forest cover intercepts snow and generally results in less snow pack. Studies in the Pend d'Oreille show that forest cover reduces snow packs by 50% of adjacent exposed areas. The dates of melting in the forest tended to be about the same as those areas with only shrub cover (Woods, pers. comm.). Our surveys in the study area indicated little winter use of high elevation forests, particularly on the north and east aspects. However, some forest cover is considered necessary to white-tailed deer during normal to harsh winters (Woods, pers. comm.). Loveless (1967) found that animals were forced to seek shelter in dense forested areas when temperatures were minus 10°C or colder, and when winds approached or exceeded 40 km per hour.

The food habits of both mule deer and white-tailed deer are quite variable and reflect the adaptability of the animals to different habitat types. Food information from various habitat types in the northwest is presented in Table 2. Both mule deer and white-tailed deer occasionally occur together; however they are usually segregated by their habitats and hence do not compete for food. Mule deer in the east Kootenays showed a positive correlation with elevation, slope and rockiness (Hudson et al., 1976). In Alberta Kramer (1972) found a similar relationship; mule deer and white-tailed deer seemed to be segregated on "the basis of elevation, ruggedness of terrain and the openess of forest and shrub vegetation". White-tailed deer tend to be associated with forested areas while mule deer are

TABLE 2: Forage Utilization of Mule Deer and White-Tailed Deer for Various Locations.

SPECIES	This Study	Pend D'Oreille Valley			E. Kootenay		Alberta	Idaho			Montana		
	MD/WT	WT	WT	WT	WT	MD	MD	MD	WT	WT	MD	MD/WT	MD
		Envirocon 1973	Envirocon 1974	Vold et. al. 1980	Demarchi 1967	Demarchi 1974	Cowan 1947	DeNio 1938	Martinka 1970	Campbell 1972	Klebenow 1965	Martinka 1967	Lovaas 1958
Abies spp.	-	-	-	L	-	-	-	-	L	L	-	-	-
Acer glabrum	M	-	H	-	-	-	-	-	-	-	-	-	-
Achillea spp.	-	-	-	-	-	M	-	-	-	-	-	-	-
Amelanchier alnifolia	H	-	H	H	M	-	-	H	-	M	H	H	-
Anemone spp.	-	-	-	-	M	-	-	-	-	-	-	-	-
Antennaria spp.	-	-	-	-	-	M	M	-	-	-	-	-	-
Arctostaphylos uva-ursi	-	-	-	M	M	H	-	-	-	-	H	H	-
Aster spp.	-	-	-	-	-	-	-	-	-	-	-	-	M
Balsamorhiza sagittata	-	-	-	-	-	-	-	-	-	-	-	M	-
Berberis repens	-	-	-	-	M	-	-	-	M	M	M	-	-
Betula papyrifera	M	-	M	L	-	-	-	M	-	-	-	-	-
Carex spp.	L	-	-	-	L	-	L	L	-	L	-	-	-
Ceanothus sanguineus	H	H	-	H	H	-	-	-	-	-	-	-	-
Ceanothus velutinus	H	H	-	H	M	-	-	M	-	M	M	H	-
Cirsium spp.	-	-	-	-	-	L	-	-	-	-	-	-	-
Cornus stolonifera	-	-	-	M	M	-	-	-	-	-	-	-	-
Corylus cornuta	H	H	H	L	-	-	-	-	-	-	-	-	-
Crataegus douglasii	-	-	-	L	-	-	-	-	-	-	-	-	-
Gramineae	M	-	-	H	M	M	M	-	-	M	-	M	L
Holodiscus discolor	-	-	-	L	-	-	-	-	-	-	-	-	-
Juniperus spp.	L	-	-	-	-	-	M	-	-	-	-	-	H
Lichens	-	-	-	H	-	-	-	-	-	-	-	-	-
Mahonia aquifolium	M	-	-	H	-	-	-	-	-	-	-	H	-
Pachistima myrsinites	-	-	-	M	-	-	-	-	M	M	-	-	-
Penstemon spp.	-	-	-	-	L	M	-	-	-	L	-	-	-
Philadelphus lewisii	-	-	-	L	-	-	-	M	-	-	-	-	-
Phlox hoodii	-	-	-	-	-	L	-	-	-	-	-	-	M
Physocarpus malvaceus	-	H	M	L	-	-	-	-	-	-	-	-	-
Pinus ponderosa	-	-	-	-	-	-	-	H	-	-	-	-	M
Populus tremuloides	-	-	M	-	-	-	-	-	-	-	L	-	-
Populus trichocarpa	-	-	-	H	-	-	-	-	-	-	-	-	-
Prunus virginiana	H	H	H	H	M	-	-	M	-	M	-	H	H
Prunus emarginata	-	-	-	M	-	-	-	-	-	-	-	-	-
Pseudotsuga menziesii	L	-	-	H	M	M	M	M	M	M	-	-	M
Rhus radicans	-	-	-	M	-	-	-	-	-	-	-	-	-
Rosa spp.	L	H	-	M	L	-	-	-	-	-	-	-	-
Rubus spp.	-	H	M	M	-	-	-	-	-	M	-	-	-
Salix spp.	M	-	-	M	M	-	-	-	M	-	-	-	-
Sambucus cerulea	-	-	-	L	-	-	-	-	-	-	-	-	-
Sheperdia canadensis	-	-	-	L	-	-	-	-	-	-	-	-	-
Spirea betulifolia	-	-	-	-	M	-	-	-	-	-	-	-	-
Symphoricarpus albus	L	H	-	L	H	-	-	M	-	M	-	-	-
Thuja plicata	-	-	-	H	-	-	-	-	L	L	-	-	-
Vaccinium spp.	L	-	-	-	-	-	-	-	-	-	-	-	-

H - High
M - Moderate
L - Low

MD - Mule Deer
WT - White-Tailed Deer

more closely associated with open rugged terrain. In winter both deer used similar browse species; up to 75% of their diets were comparable in Montana (Martinka, 1968). Competition for food is minimal because spatial separation is usually maintained. In the East Kootenays white-tailed deer were usually found at lower elevations on gentle lower slopes, in uniform fir - pine forests with high shrub densities (Hudson et al., 1976). Mule deer utilized more rugged areas at higher elevations where snow was sparse. These latter areas were primarily open shrub communities with good crops of bunch grass (Hudson et al., 1976).

Preferred browse species in the Pend-d'Oreille Valley of the West Kootenays were identified as choke cherry, hazelnut, buck thorn, and saskatoon (Envirocon, 1974). Other species which were used to a lesser extent were Douglas maple, ninebark, raspberry, trembling aspen and paper birch. In a separate report, Ceanothus spp., snowberry and rose were identified in addition to raspberry, ninebark, cherry, hazelnut as important browse species along the Pend-d'Oreille Valley (Envirocon, 1973). A further feature in this valley was that areas of shrub were separated by mixwood; this is regarded as a desireable combination for white-tailed deer.

4.1.3 Ungulate Abundance

4.1.3.1 Aerial Surveys

Ungulate populations in the West Kootenay region, as in many other areas of North America, are governed to a large extent by the availability of suitable winter range. For this reason the ungulate field program in this study concentrated on the distribution of animals over the critical winter period. Four aerial surveys of the study area were conducted on 17 January and 16 February 1981; and 4 January and 18 March 1982. The results of these surveys are shown on Figures 5, 6, 7 and 8, respectively.

Six mule deer and two white-tailed deer were observed during the January 1981 survey. On February 16, 1981, five mule deer and seven white-tailed deer were observed along the survey route. At first glance these figures would indicate that winter deer populations on the study area are relatively low. However, because of

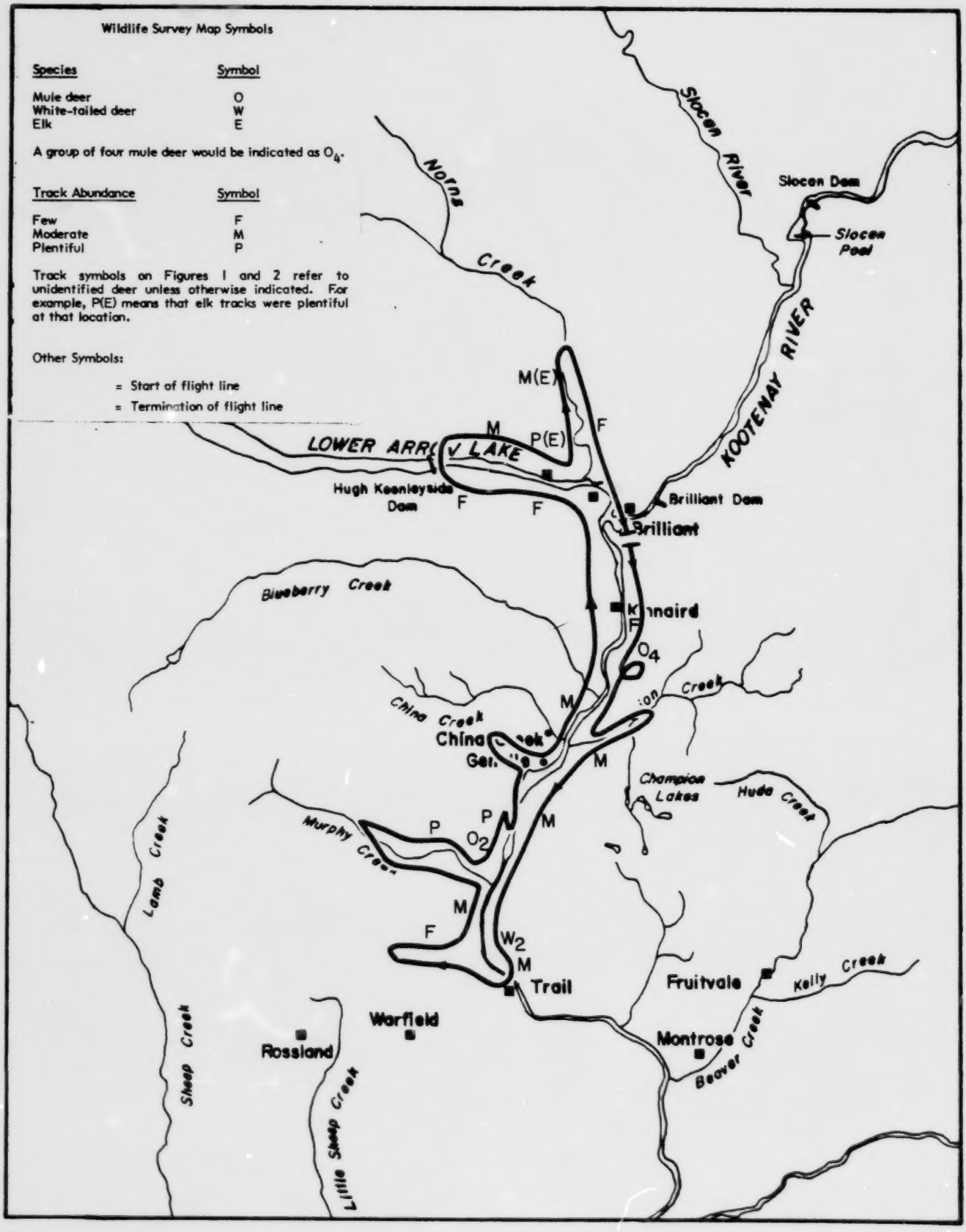


FIGURE 5 : Results Of Helicopter Wildlife Survey Of The Study Area, January 17, 1981.

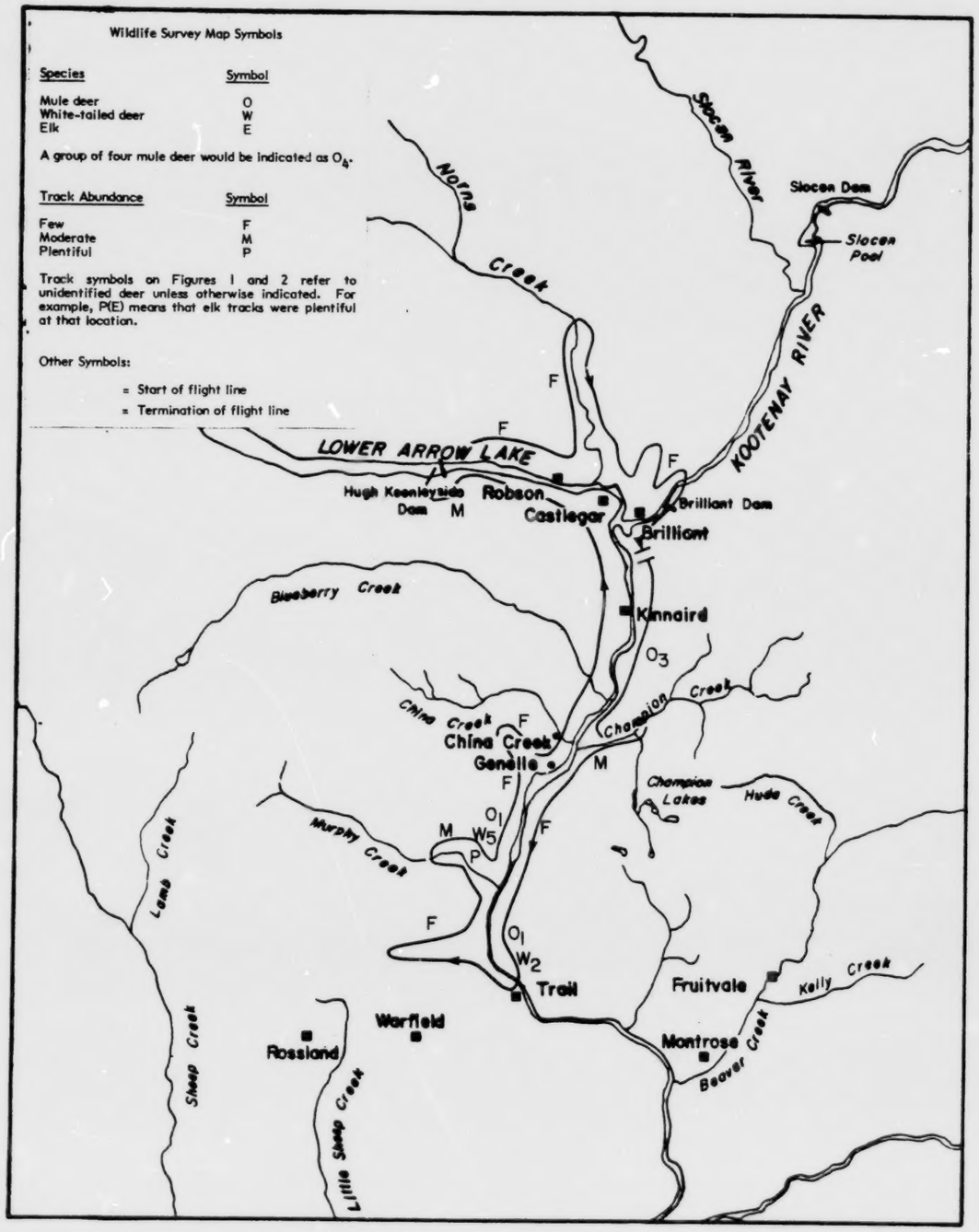
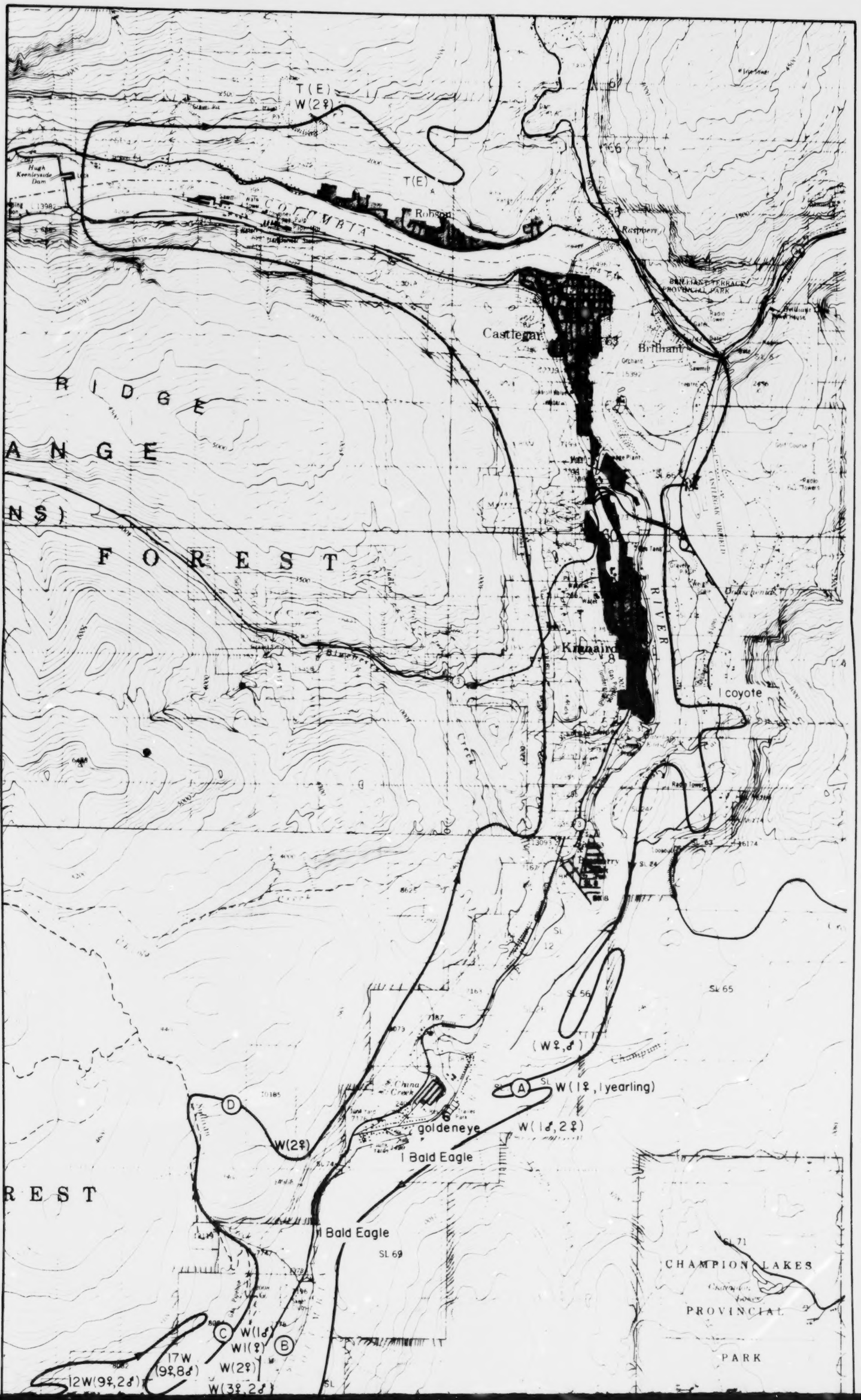


FIGURE 6 : Results Of Helicopter Wildlife Survey Of The Study Area. February 16, 1981. (See Figure 5 for a Key to Survey Symbols.)


T(E)
W(2♀)
T(E)
Hugh Keenleyside Dam
COLUMBIA
Robson
Raspberry
BATTLEFORD TERRACE PROVINCIAL PARK
Castlegar
Brilliant
RIDGE
ANGE
N$)
FOREST
Kinnaird
RIVER
1 coyote
Sk 65
(W♀,♂)
A
W(1♀, 1 yearling)
W(1♂,2♀)
goldeneye
1 Bald Eagle
W(2♀)
D
REST
1 Bald Eagle
SL 69
CHAMPION LAKES
PROVINCIAL
PARK
C
W(1♂)
W(1♀)
B
17W
(9♀,8♂)
W(2♀)
12W(9♀,2♂)
W(3♀,2♂)

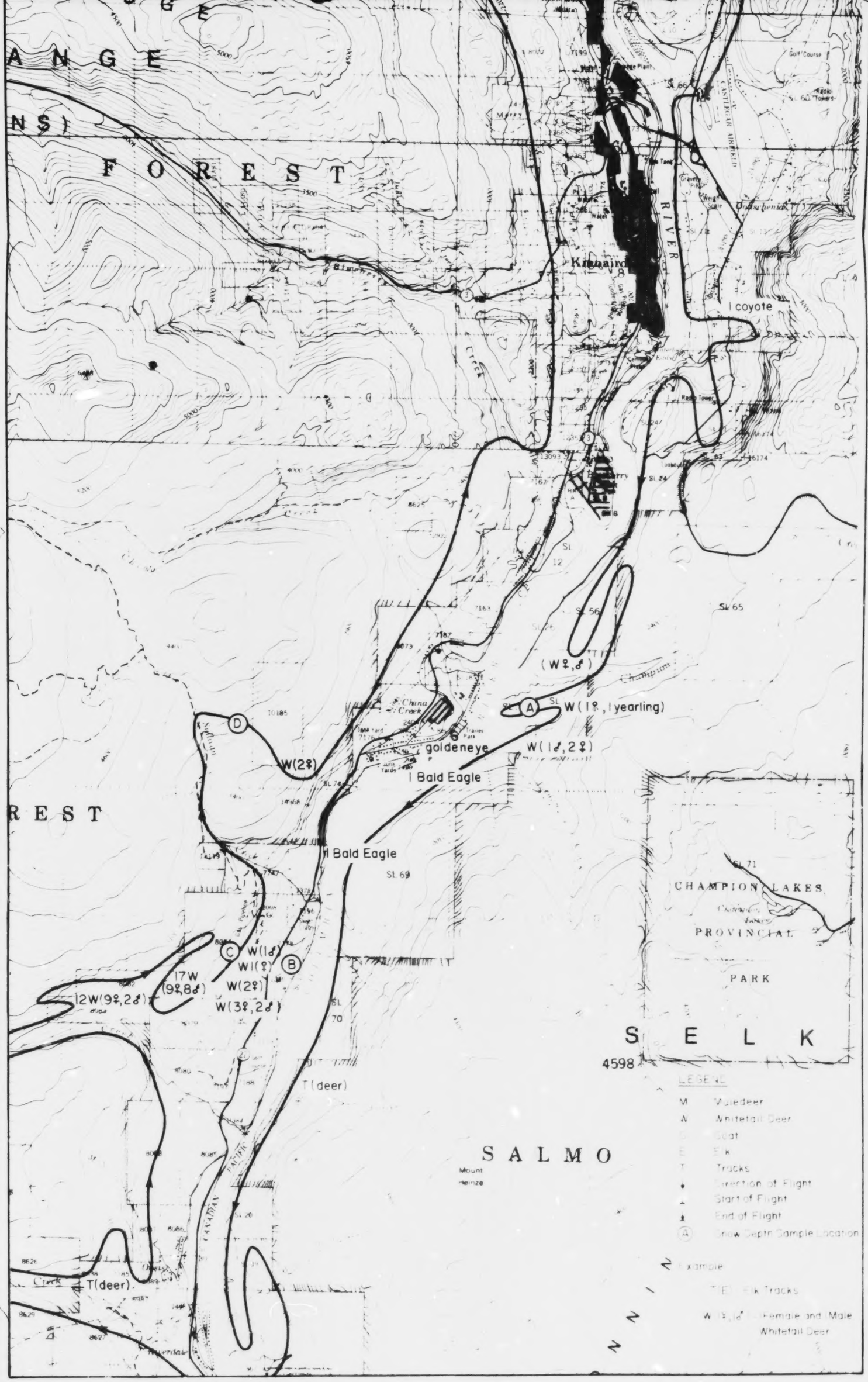
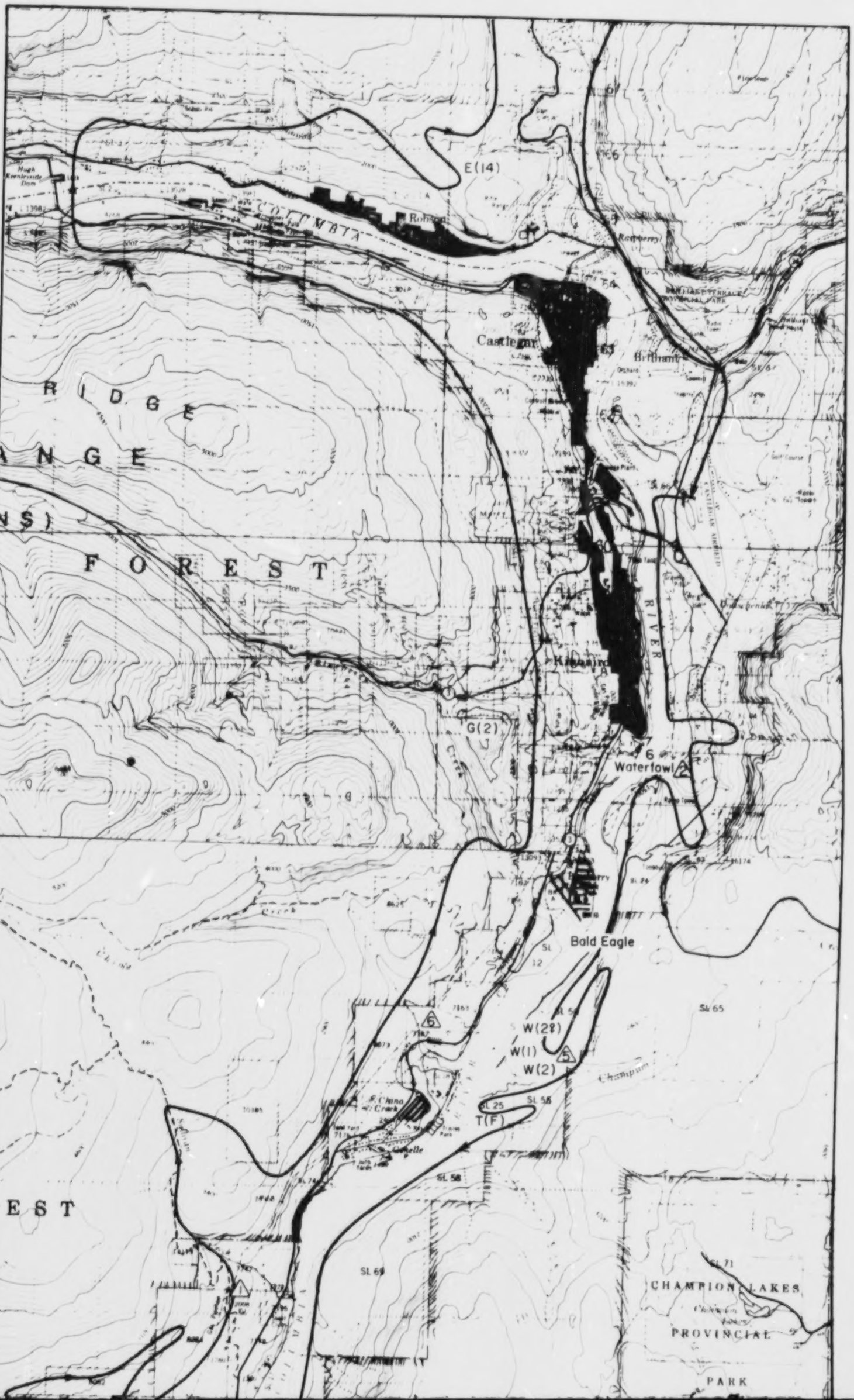


FIGURE 7: Aerial Survey Conducted January 4, 1982


E(14)
COLUMBIA
Robson
Castlegar
Brilliant
RIDGE
NGE
NS)
FOREST
RIVER
G(2)
Creek
6
Waterfowl
Bald Eagle
W(28)
W(1)
W(2)
T(F)
SL 25
SL 58
SL 65
SL 69
SL 71
CHAMPION LAKES
PROVINCIAL
PARK
REST

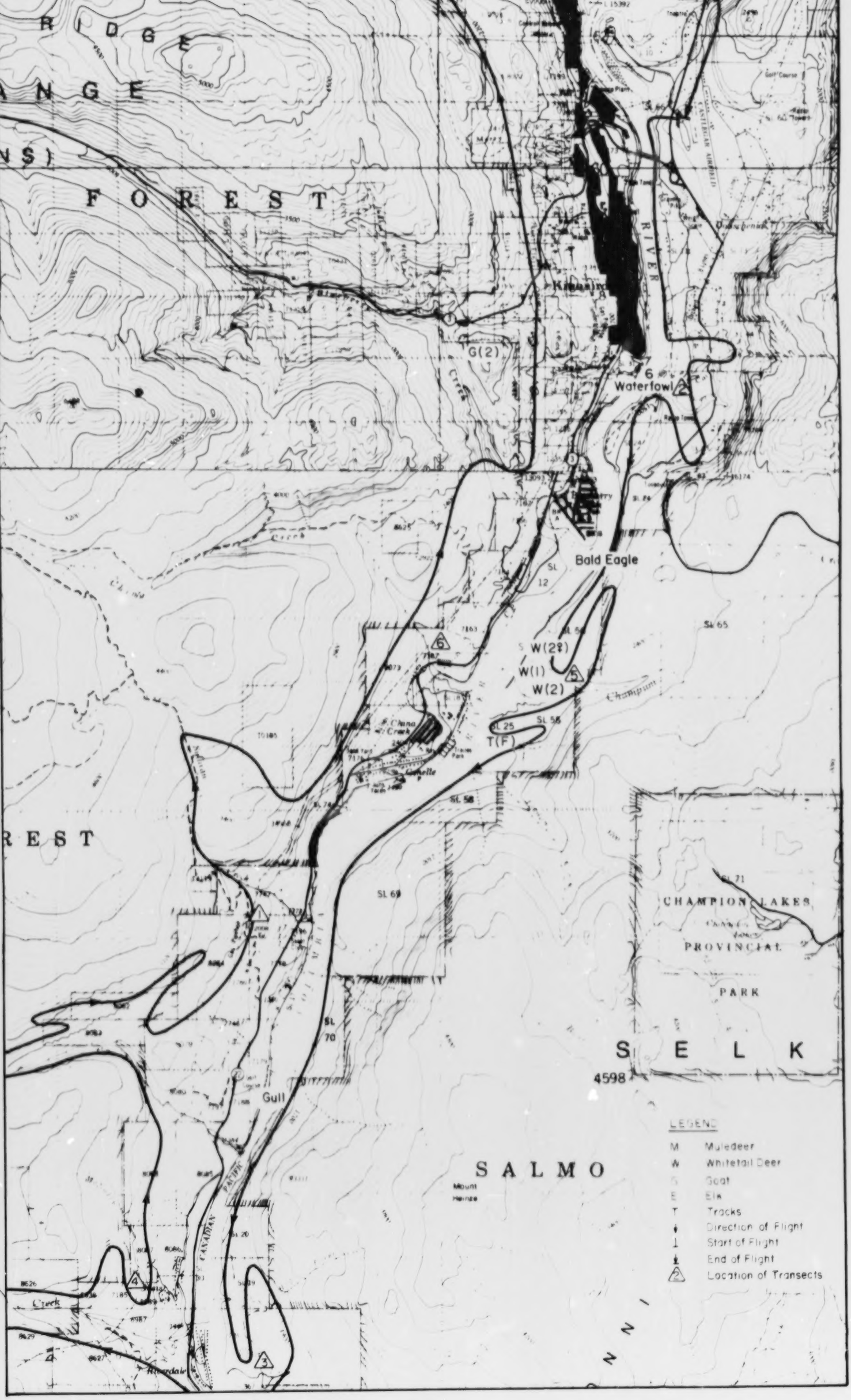


FIGURE 8 : Aerial And Ground Surveys Conducted March 18, 1982.

the lack of snow during the late winter, both surveys were of necessity conducted under poor sighting conditions where snow patches covered approximately 50% of the ground in most areas. Observability tests conducted in mixed deciduous - coniferous forests (Floyd et al., 1979) under ideal sighting conditions of clear to bright - cloudy light conditions and complete snow coverage of the ground indicated that only one half of the deer present were seen. In view of the field conditions encountered during the January and February aerial surveys of the study area, we assume that approximately 25% of the deer present along the flight line were enumerated. Correcting the survey data with this observability bias factor yields estimates of 32 and 48 deer present along the survey routes in January and February, respectively.

During the January 4, 1982 survey, the majority of deer were observed on the southeast facing slopes between Sullivan and Murphy Creeks. The 38 white-tail deer observed in the area accounted for over 75% of the total deer observed during this survey. Very few tracks or sign were observed in the rest of the study area. A total of 49 deer were observed along the survey route.

During the March 18, 1982 survey, a herd of 14 elk were observed on a ridge above Robson and 5 white-tail deer were observed at Champion Creek. The lack of animals observed during the March survey was probably due to lower snow depths and the opening of other areas.

Woods (pers. comm.) found in the Perd d'Orielle that only 10-15% of total deer were observed during aerial surveys. However, the visibility was poorer because of greater forest cover. So in an area with slightly less cover and good flying conditions, the assumption that 25% of animals present were observed was retained. The result would be that the total deer present along the flight line during January and March surveys in 1982 were 196 and 20, respectively. The mean is 108, much greater than the 1981 mean estimate of 40 deer. Owing to the great variability in 1982 survey results, a combined mean estimate of 74 deer appears more realistic. It is possible that the milder winter of 1981 allowed for a greater dispersal of animals whereas the more severe or normal winter of 1982 showed a greater restriction of range, hence more deer below 500 m, particularly in January.

Some comment should be made about the elk population. A small herd was transplanted to the Syringa Creek area some 7 km upstream of the Hugh Keenleyside Dam in 1972, at the west end of an existing local elk range mapped in Cowan and Guiguet (1965). Whatever their origins, the elk population immediately north of Castlegar is now estimated at 150 to 200 individuals (G. Woods, pers. comm).

Surveys conducted as part of this investigation confirmed the presence of elk and their tendency to occupy habitats above 500 m. Elk sign was plentiful in Pass Creek valley and on the south-facing ridge above Robson on both January wildlife surveys, although no animals were seen. A small herd (8 to 10 individuals) was observed along Pass Creek approximately 8 km upstream of the Columbia River confluence a few days prior to the January 1981 survey (B. and R. Shingler, pers. comm.). Fourteen elk were observed on the ridge above Robson during the March 1982 survey.

4.1.3.2

Interviews were held with locally knowledgeable individuals, members of the Trail Wildlife Association, and the regional wildlife biologist (Guy Woods) of the B.C. Fish and Wildlife Branch. In addition, road kill information for the study area was provided by W. Campbell, Conservation Officer for the Trail area (Appendix 3-1). Appendix 3-2 contains wildlife sighting records for the study area as provided by members of the Trail Wildlife Association. There was a general consensus of local opinion that the Columbia River valley, between Trail and Castlegar, provides winter range for 100 to 200 deer during normal winters. Some felt these figures could double temporarily under severe winter conditions.

4.1.3.3

Browse and pellet group plots were assessed along seven transects within the study area to coincide with the vegetation transects of Talisman Projects Inc. in mid-October 1981 and March 1982. Transects were established perpendicular to the valley and extended along compass bearings from river's edge to the 500 m contour.

Vegetation, topographic information, and wildlife sign was recorded along transects. Detailed browse and pellet group plots (5 x 10 m) were located every 50 meters along these transects. Data collected for each plot included cover assessments for tree, shrub and forb species, the amount of browsing (light, moderate, heavy) and the number of pellet groups within the plot. The results of the 1981 plots are presented in Appendix 3-3, and are summarized in the following descriptions. The March 1982 survey results are summarized following the 1982 results.

October 1981 Surveys

Robson Ridge

The Robson ridge transect was located between the Hugh Keenleyside Dam and the BC Timber Ltd. mill on a north-facing slope. The transect was initiated at a gravel bar at the edge of the river and proceeded up the 30° gravel slope to the first terrace. No wildlife sign was observed on this slope. The transect proceeded through some disrupted areas, gravel pits, roads, etc. and no wildlife sign was observed in any of these areas. After crossing the road the transect proceeded into black cottonwood forest with a canopy closure of about 30%. The understory shrubs were quite dense in this area. Scattered individuals of redstem ceanothus near the transect showed heavy browsing, although willows and hazelnut showed no indication of browsing. After crossing the main highway the forest cover changed from the black cottonwood forest to a forest dominated by white birch with occasional Douglas fir. The understory was dense, dominated by Oregon grape, bracken fern and some grass. There was no indication of browsing or tracks in this area. Further upslope there were a few deer tracks, but other sign was extremely limited. The transect was terminated at approximately the 500 m contour level, in a white birch forest with little wildlife sign. This area does not appear to be important for wildlife, particularly deer.

Keenleyside

This transect was located on the north side of the Columbia River between the Hugh Keenleyside Dam and the village of Robson. The transect was begun on a gravel bar at the river's edge. The initial 50 m of the transect were up the steep gravel slope from the river to the first terrace. This terrace was dominated by grass and knapweed. No wildlife sign was observed on either the slope or the terrace. Across the road the terrace proceeded across pasture land containing a few specimens of trembling aspen, Douglas fir and white birch. No sign was observed until the slope became steeper (30-35^{o}). Here Ponderosa pine dominated the overstory and game trails were found. Although the shrub area was restricted there were indications of light browsing on nearby young Douglas maple and hazelnut. The transect terminated at the top of the slope on a level terrace where there was a relatively dense stand of Douglas fir and a relatively dense shrub understory.

Pass Creek

The Pass Creek transect was chosen on the east side of Pass Creek because this reflected more undisturbed conditions than were present on the west side. The Pass Creek transect originated in the lowlands adjacent to the creek within the Pass Creek Regional Park. The forest cover at the initiation of this transect was dense white birch and black cottonwood. The understory was also extremely dense with a variety of shrub species. Although an abundance of browse species were present, there was no indication of wildlife use. This is probably attributable to the heavy human use of the park and the large amount of settlement in areas nearby. Further upslope, bear droppings were sighted.

Above the Pass Creek road the south slope became steeper (30%). The forest cover was dominated by Douglas fir with minor components of Ponderosa pine, red cedar and larch. The shrub understory was varied but relatively open. Numerous game trails and pellets were observed along the transect. Although most plant species showed little sign of past browsing, heavy browsing on Saskatoon was noted wherever this species occurred. The transect was terminated at the top of the

slope at a level terrace. This area had an 80% crown closure of primarily red cedar and western hemlock. The forest floor was sparsely vegetated in this area. This slope, from the road to the termination of the transect, was assessed as good winter range, primarily because of the abundance of browse species on the slope, the evidence of wildlife use of this area, and the presence of a dense forest for shelter.

Champion Creek

The Champion Creek area is diverse, both in terms of landform and vegetation cover and hence is difficult to sample. Our transect traversed a large portion of grassland which showed signs of cattle use only. At the tops of the terraces there was an abundance of browse species which had been heavily browsed; however, because there were many cattle in the area, it was difficult to distinguish whether these species may have been browsed by deer or cattle. In this area competition likely exists between cattle and deer. Our surveys in October showed that the grassland was being over-grazed by the cattle and they were moving into shrub areas to browse. This browsing results in a depletion of winter food sources for deer. The browse species which had been extensively used in this area were apple, hazelnut, redstem ceanothus, rose, snowberry, Douglas maple and snowbrush. All of these showed moderate to heavy use with the exception of rose and Douglas maple which were only lightly browsed. Bear droppings were also found in the area.

China Creek

The China Creek transect began at a gravel bar on the river and proceeded up the steep southeast-facing gravel slope to the top of a terrace. The slope had a fairly dense vegetation cover dominated by snowbrush, juniper and boxwood. A small game trail was noted at a break in the slope. Light browsing was observed on snowbrush and snowberry. There was also sign of bear use along this slope. The top of the terrace had a dense shrub growth and sign of light browsing on hazelnut and saskatoon. The center of the terrace was meadow surrounded by redstem ceanothus and hazelnut. Both of these species were moderately browsed. Old deer

pellets were found and plants showed evidence of considerable browsing. Bear droppings were also present. This location likely represents favourable deer winter habitat as it offers a mixture of browse species as well as a nearby deciduous forest. The only drawback to the present situation is that deer must cross the highway to get from one area to another. The road kill information in Appendix 3-2 reveals the high rate of mortalities among deer wintering along the highway in this area. Across the highway there was another band of dense shrub dominated by willows and hazelnut. From this area a steep slope led to a second terrace. This slope contained abundant browse species and deer sign, game trails and beds. The top of the terrace supported mature birch forest with a 40% crown closure and an understory dominated by bracken fern. The lush shrub growth on the slopes may be a function of seepage and hence increased moisture supply. This site appeared to be one of the better wildlife areas surveyed.

Murphy Creek

This transect proceeded from river's edge through an area of shrubby vegetation to the highway and then up a steep northeast facing slope. No wildlife sign was observed in the open shrub land below the highway, even though abundant palatable shrub species were present. At the high elevations on the transect deer tracks were observed as was light browsing on nearby willow and hazelnut bushes.

Billy Creek

This transect was located just north of Billy Creek adjacent to the potential dam site. It initially crossed the steep gravel slope from the river to the top of the terrace. Little vegetation was evident along the slope, only a few saplings of black cottonwood and trembling aspen were present. The terrace in this area is relatively wide and is characterized by a deciduous forest dominated by white birch and trembling aspen. The understory contains few shrub species, but an abundance of bracken fern. Light browsing was observed only on saplings of white birch. As the slope became steeper, the bracken fern diminished in importance and hazelnut, Oregon grape, boxwood, and grasses were abundant. Although no other sign was observed in this area, light browsing on hazelnut was evident.

Till Sites

Three potential till sites were initially identified by B.C. Hydro. Of these sites, only in the Murphy Creek drainage was adequate till material found. It is accessible by trail along the north side of Murphy Creek at an elevation of approximately 915 m.

The vegetation in this area shows a strong response to aspect. The south aspects were dominated by a broad leaf forest. Birch was the most abundant tree species; however, others of importance were black cottonwood, mountain alder, western larch, and trembling aspen. The understory species included Saskatoon, willow, hazelnut, snowberry, Oregon grape and boxwood. The ground flora was predominantly grass, bearberry and moss with few other species. Trembling aspen gained importance with an increase in elevation until, at a level of approximately 854 m aspen clones dominated the area. The inter-clonal areas were occupied by Saskatoon, rocky mountain juniper and snowberry. Hazelnut and Oregon grape were also common but scattered in their distributions. The understory was comprised of abundant grasses, mosses and bearberry.

The winter surveys revealed extensive deer use of the south and south-east aspects of the Murphy Creek drainage basin. The major area of deer concentration occurred from approximately the 800 m elevation on the north side of the creek, due east to the top end of Johnson Creek. This area has been classified as having a moderate to high habitat rating (Figure 9). The value of this area is due to its uniqueness as one of the very few south facing, low elevation slopes in the study area. It is dominated by a sparse deciduous forest predominantly composed of birch and aspen. The open tree canopy is complimented by a strong shrub component comprised of Saskatoon, willow, snowberry and hazelnut among others. At the lowest elevations the shrub cover predominates and only a few scattered trees occur. Extensive track patterns and relatively large numbers of white-tailed deer were observed in this area during most of the winter surveys.

Areas of low to moderate wildlife value include the lower elevation and east facing slopes east of the "knoll" (above the golf-course) (Figure 9). This area is subject to

more human influence, has less favorable shrub species and little forest cover. It seems, therefore, to receive little winter use.

March 1982 Surveys

Of the six transects covered in March 1982, four had been described during 1981 studies. Cai Creek and Sunningdale were done for the first time in 1982 and are described. However, due to the presence of snow and the early date, detailed descriptions of ground cover were not done. Browse and pellet observations for all transects are also included.

Cai Creek

This transect was located in the area above the garbage dump. This transect consisted of a mixed forest of aspen and lodgepole pine with some birch. Canopy closure ranged from 10% to 50%. Shrub understory consisted of Oregon grape, false box, hazelnut with some yellowstem ceanothus, regenerating lodgepole pine, regenerating aspen and Saskatoon. Some evidence of browsing was found on hazelnut, yellowstem ceanothus and Saskatoon. Snow depths ranged from 25 cm to 38 cm. Very little sign, either track or pellet groups were found.

Sunningdale

This transect was located near the gravel pits north of Sunningdale. The overstory in this area was dominated by aspen, with some birch and lodgepole pine. In certain sections hazelnut and willow comprised the overstory. The shrub layer was dominated by false box, Oregon grape and bracken, with some grasses, rose, Saskatoon, yellowstem ceanothus, willow and regenerating birch. Small amounts of browsing were recorded on Saskatoon, yellowstem ceanothus and hazelnut, and very little sign was noted. Snow cover in this area was patchy, ranging from 20-90% with depths from 15 to 28 cm.

Murphy Creek

Little browsing was evident along the transect. In one plot, trace browsing was evident on hazelnut and in another a false box was heavily browsed. Tracks and trails were evident all along this transect.

Champion Creek

On this transect, considerable tracks and evidence of browsing were found on lodgepole pine, false box, Oregon grape and willows. Tracks and bed areas were also noted.

China Creek

Some evidence of old browsing was found on redstem ceanothus. This transect crossed two old deer trails, but no other sign was found.

4.1.3.4 Habitat Capability

Our observations indicate that the Columbia River valley is not unusual in its distribution of ungulates or habitat. The mule deer and white-tailed deer in the area conform to general movement and habitat use patterns exhibited by deer in the Pacific northwest. The mule deer use high elevation areas containing highly nutritious forage during the summer when forage is poor in the arid valley. They move to low valley slopes, below 1,220 m, during the winter in response to greater food availability and ease of movement. The white-tailed deer do not exhibit such extreme movement patterns. They remain in valley bottoms and on low elevation benches throughout the year (below 1,070 m in winter), but make use of a wider range in summer than in winter. Our browse studies indicated that low elevation areas were used by deer in late summer. This conclusion was confirmed by incidental observations of white-tailed deer in the study area during the summer of 1980 (Baker, pers. comm.).

In general, the amount of suitable winter habitat is the critical limiting factor for both white-tailed deer and mule deer. Snow depths and the availability of food are the two overriding concerns for both species of deer in the study area. Meteorological records indicate that high elevation areas in the Columbia River valley are subject to heavy snowpacks in winter, while low elevations have considerably lighter snowpacks. Snowpacks are less severe for wintering deer on south and southwest facing slopes, and preferred browse species are more abundant on these slopes than others. Our winter wildlife surveys confirmed that deer were using the south and southwest facing slopes extensively. Such slopes are uncommon in the study area primarily because of the north-south orientation of the river valley over most of the study area. Much of the available winter deer habitat is therefore associated with the east-west oriented creeks draining into the Columbia River, and occurs for the most part above the 500 m limit of the study area.

The history of the study area has had a profound influence on wildlife habitats. The low terraces favoured by deer have to a large extent been alienated by residential, industrial, linear (road and power line) and agricultural developments. The fire and pollution history of the Columbia River valley has in part enhanced wildlife habitats, but has also reduced the value of habitats in other areas. In those portions of the study area which were subject to the severe fires and sulfur dioxide damage, wildlife habitats are virtually nonexistant because of the inability of bare substrates to support a productive assemblage of browse species. These conditions are most apparent near Trail, particularly at high elevations. In less severely affected areas the results have retarded normal plant succession and have thus allowed an abundant supply of browse species. Local topographic, climatic and substrate conditions have also influenced the ability of forest stands to regenerate once disturbed.

The extent of winter range used by deer depends on the severity of the winter. In the study area the winter of 1980-81 was mild in comparison to the winters of the previous decade. Although heavy December snows probably forced deer onto their winter range, the ensuing mild conditions allowed the deer to use a larger area than in normal winters. We observed deer feeding on grasses in late January on

southwest facing slopes where snow conditions were patchy. Conversely, the winter of 1982 was more characteristic of the area. During the midwinter aerial survey of January 4, 1982, deer distribution appeared to be restricted considerably and densities greater than in 1981. The majority of animals were observed in the south and southeast slopes along Murphy Creek. The other area with any number of animals were the west-facing slopes and terraces of Champion Creek. Later on in the 1982 winter (March), conditions were considerably milder and very few animals were observed. By March, their range was much less restricted and they were moving out to areas newly exposed by the quickly retreating snow.

In summary, our studies found that deer winter habitats were restricted primarily to south, southwest and southeast facing slopes and terraces. Most of the deer winter range appeared to be above the 500 meter contour. The steep slopes from the lowest terrace (at 460 m) to the river did not provide useful ungulate habitat and were used only by animals in transit.

The most important winter range locations in the study area in order of decreasing importance are:

Murphy Creek. The south and southeast exposures provide the largest area of deer winter range available in the Columbia River valley. This is based on aerial and ground surveys of the till site area. However, this high value area does not extend below the 500 m contour, based on our surveys (Figure 9).

Champion Creek. The terraces and southwest exposures provide good winter range potential. At present competition likely occurs between cattle and deer.

Cai Creek Terraces (above garbage dump). These terraces slope gently to the west and provide an abundance of browse. Extensive deer use was first observed in this area during the January and February 1981 surveys. March 1982 surveys indicated a much lower level of utilization than during 1981 field studies.

Terrace on east side of river, across from Sullivan Creek. This terrace, although not notable for its abundance of browse, is valuable because it occurs in an undisturbed area. It provides a transportation corridor for deer moving north and south along the east side of the river.

China Creek. The terraces and southeast exposures contained abundant browse and showed signs of use. The value of this area is limited by the location of the highway.

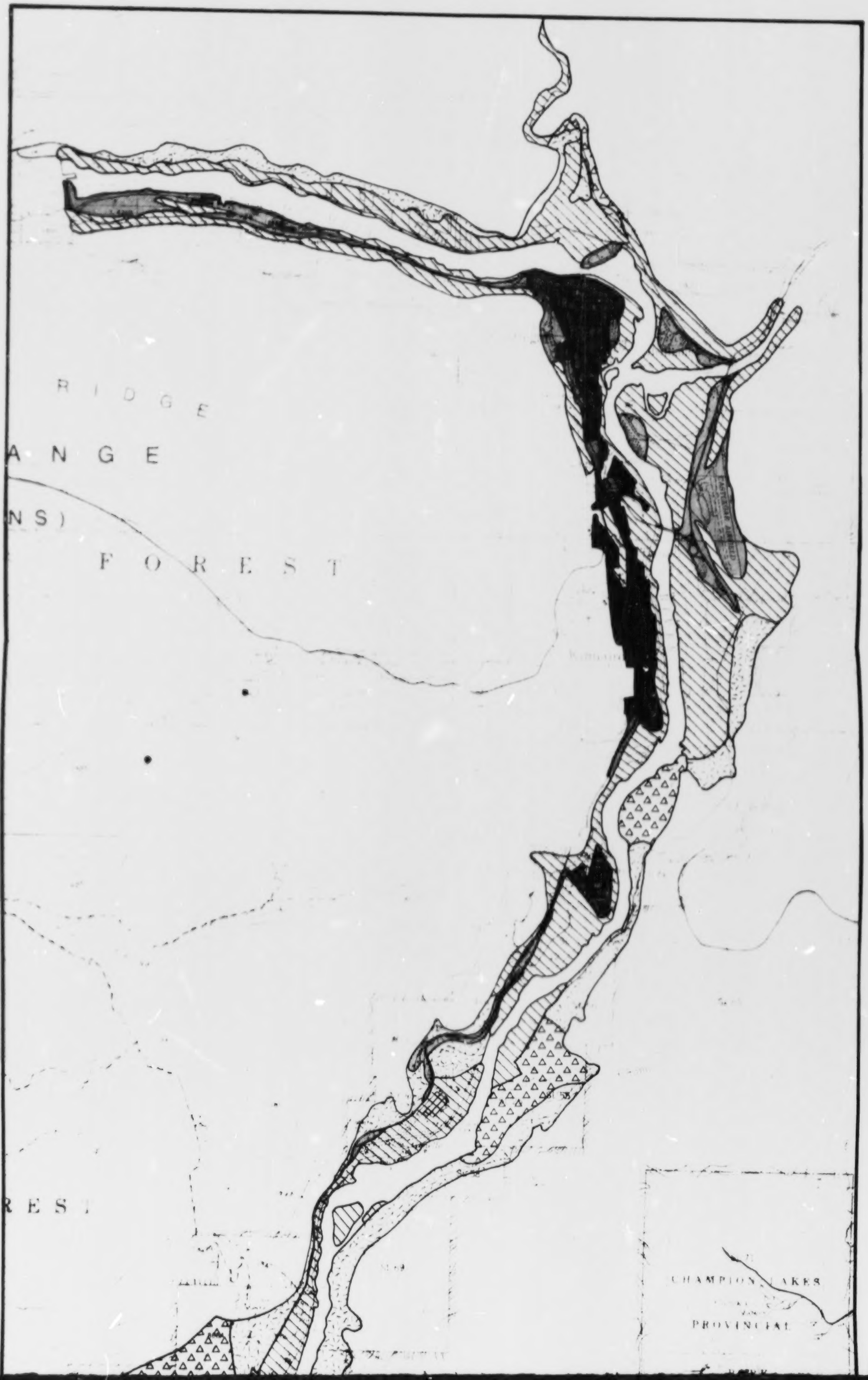
Pass Creek. The southwest exposures above the settled areas showed extensive use by deer. This area was mostly beyond the study area boundary.

The south facing slopes in the vicinity of Robson. Much of this area is alienated by settlement patterns and agricultural uses. Gravel pit areas beyond the study boundaries present some potential for reclamation.

These areas have also been given a subjective habitat rating. These ratings were based primarily on browse and pellet group survey information, animal sightings and track concentration. The categories are: i) altered (i.e. by development); ii) very low; iii) low-moderate; and iv) moderate-high (Figure 9). Moderate-high utilization areas amount to only 7% of the study area. Low-moderate capability areas amount to a further 20%. The remaining 73% represents a low value winter habitat capability (Table 3). These ratings are based on more than habitat capability. The assessment took into account present land use and therefore is an assessment of actual wildlife use rather than capability. The browse survey results were compared to their land capability ratings in order to estimate ungulate densities. These categories correspond in general to the following land capability classes:

TABLE 3: Estimated Areas of Habitat Units

Habitat Unit	Area (hectares)
Altered	776
Very Low	1873
Low to Moderate	710
Moderate to High	258


RIDGE
ANGE
NS)
FOREST
CHAMPION LAKES
PROVINCIAL

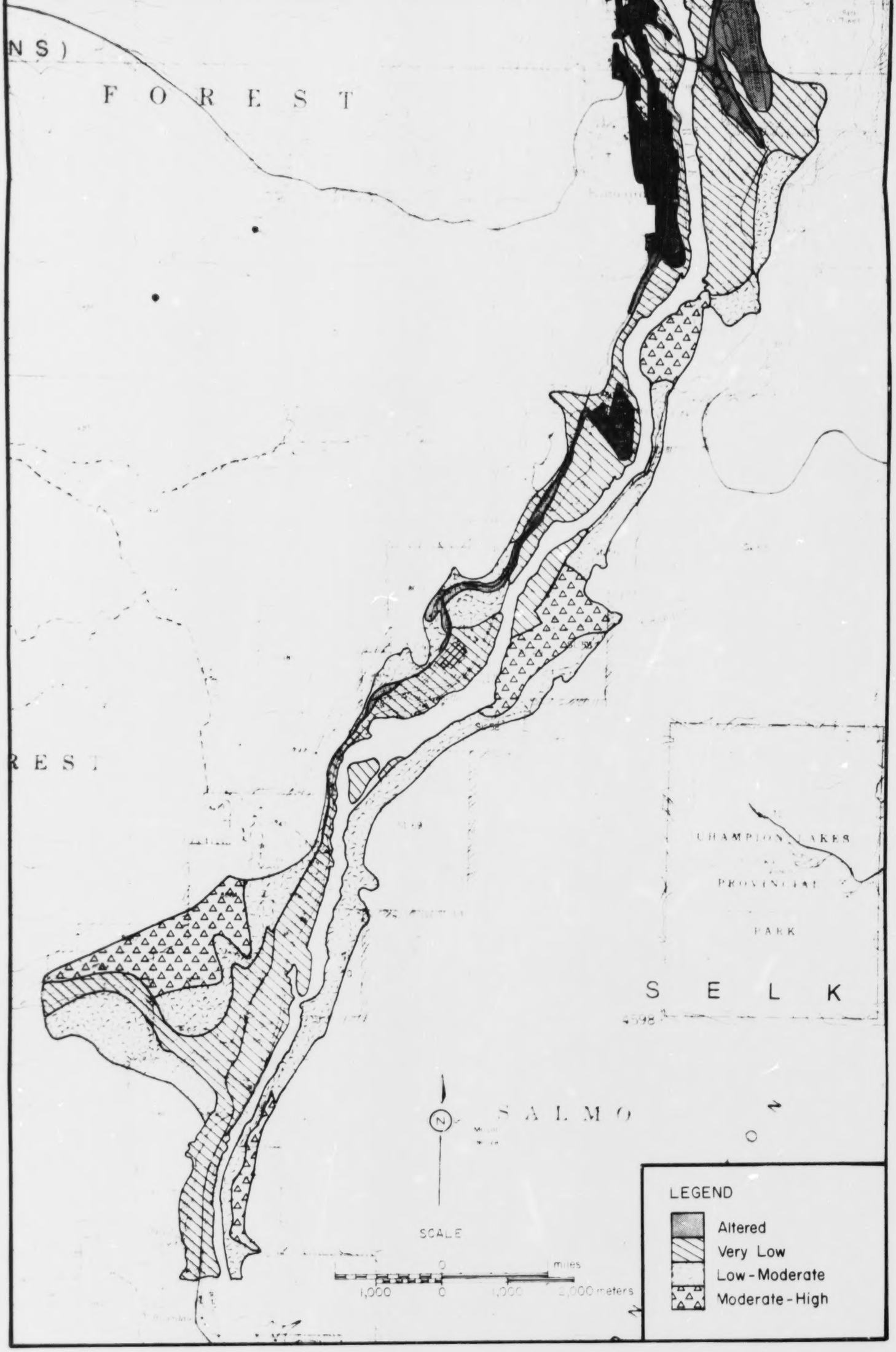


FIGURE 9 : Ungulate Habitat Distribution in the Study Area.

Moderate to High

Class 3 (Blower, 1973) "Lands in this class have moderate limitations to the production of ungulates. The area so classified will sustain a population of (or equivalent to) 40-60 white-tailed deer per square mile per year" (15-23 per square km per year).

Class 3 (D. Demarchi, 1979) "Units in this class have moderate limitations to the growth of native herbs or shrubs ... canopy coverage of 10-25 percent of shrubs". Demarchi et al. (1982) have estimated the carrying capacity of this class ('Moderate') as 6-11 mule or white-tailed deer per square km per year.

Low to Moderate

Class 4 (Blower, 1973) "Lands in this class have moderately severe limitations to the production of ungulates. The area so classified will sustain a population of (or equivalent to) 20-40 white-tailed deer per square mile per year" (8-15 deer per square km per year).

Class 4 (D. Demarchi, 1979) "Units in this class have moderately severe limitations to the growth of native herbs or shrubs ... they have a canopy coverage of 5-10 percent shrubs."

Demarchi et al. (1982) have estimated the carrying capacity of this class ('Low') as 1-5 mule or white-tailed deer per square kilometer per year.

Very Low

Class 5 and 6 (Blower, 1973). Lands in these classes are attributed with severe to very severe limitations to the production of ungulates. The population estimates are 1 to 20 white tailed deer per square mile per year (classes combined) or 1 to 8 deer per square km per year. Classes 5 and 6 in Demarchi (1979) are described as having severe limitations to the growth of native herbs and shrubs. Canopy

coverage ranges from nil to 5 percent. Demarchi et al. (1982) have assigned these classes a carrying capacity of less than 1 animal per square kilometer per year.

The altered class has not been compared to capability ratings because it is unlikely that these areas could sustain any ungulates without the benefit of surrounding habitats. Animals using these areas are likely sporadic visitors benefiting occasionally from garden produce.

In all of the transects there was a pattern of increased wildlife use with increased elevation from the river to the 500 m contour. The south and west aspects around the 500 m contour showed the heaviest wildlife use in the study area. Of all the areas surveyed, the Murphy Creek area appeared to have the most suitable habitats and to be the most used by wildlife.

4.1.4 Consumptive and Non-consumptive Use

The consumptive uses of game animals encompass legal and illegal harvesting for both sport and food purposes. Non-consumptive uses are generally considered to include nature study, photography and viewing. Compared with other recreation activities in the study area, wildlife viewing placed seventh and hunting placed eleventh out of twelve (Edwin, Reid and Associates, 1981). Since this list included swimming, sightseeing, picnicing, and camping activities which involve considerably less preparation and skill, the low ranking of hunting is potentially misleading. Compared with nearby locations (e.g. Arrow Lake, Slocan River) hunting in the study area by study area residents ranked highest (14.2% of hunting days); however, local hunters spent three times as many (42.2%) hunter days in more remote locations (Edwin, Reid and Associates 1981). Our discussions with members of the Trail Wildlife Assocation indicated that even though the number of hunters might not compare with other recreational activities and might be pursued most actively elsewhere, hunting was an important activity and concern for local and regional wildlife resources was high.

Estimates of big game harvests by Management Unit (MU) for the Kootenay Region (Region 4) obtained from the B.C. Fish and Wildlife Branch reveal that over the

period from 1976 to 1979 the four Management Units (MU's 4-8, 4-9, 4-14 and 4-15), within which the study area lies, accounted for only a low proportion of the deer, black bear and elk harvests of the entire region (Table 4). As inferred by Edwin, Reid and Associates (1981), hunting in the study region is not high. Since hunting terminates in the week of December 10 in M.U. 4-8, 4-9 and 4-14 and November 30 in M.U. 4-15, when deer are likely to be found over a wide range of elevations, hunting in the study area is likely to be minimal. Moreover, the study area up to 500 m represents only 0.6% of these management units.

TABLE 4: Estimated Harvest of Black Bear, Elk and Deer in M.U. 4-8, 4-9, 4-14 and 4-15 during the period 1976-1979. Proportion of Regional Harvest in Parenthesis

	1979	1978	1977	1976
Black Bear	67 (12%)	89 (13%)	108 (15%)	57 (11%)
Elk	7 (<1%)	2 (<1%)	5 (<1%)	3 (<1%)
Deer	385 (8%)	303 (7%)	408 (8%)	204 (7%)

Source: B.C. Fish and Wildlife Branch, Victoria

4.2 Furbearers

4.2.1 Trapping Activity

Five traplines are registered in the region of the proposed Murphy Creek development (Figure 10). Beaver and red squirrels provide most of the fur harvest for the traplines potentially influenced by the proposed development (Table 5). However, the contribution to annual income based upon the average 1977-1980 fur prices is highest for lynx (Table 6).

The latest year for which trapline harvest statistics are available (1979) shows a range in earnings from these traplines of $365.53 to $2,946.22, with a mean yearly value of $1,606.08. It is difficult to provide a meaningful, longer term perspective

FIGURE 10 :
APPROXIMATE LOCATION
REGISTERED TRAPLINES
BORDERING THE PROPOSED
MURPHY CREEK PROJECT

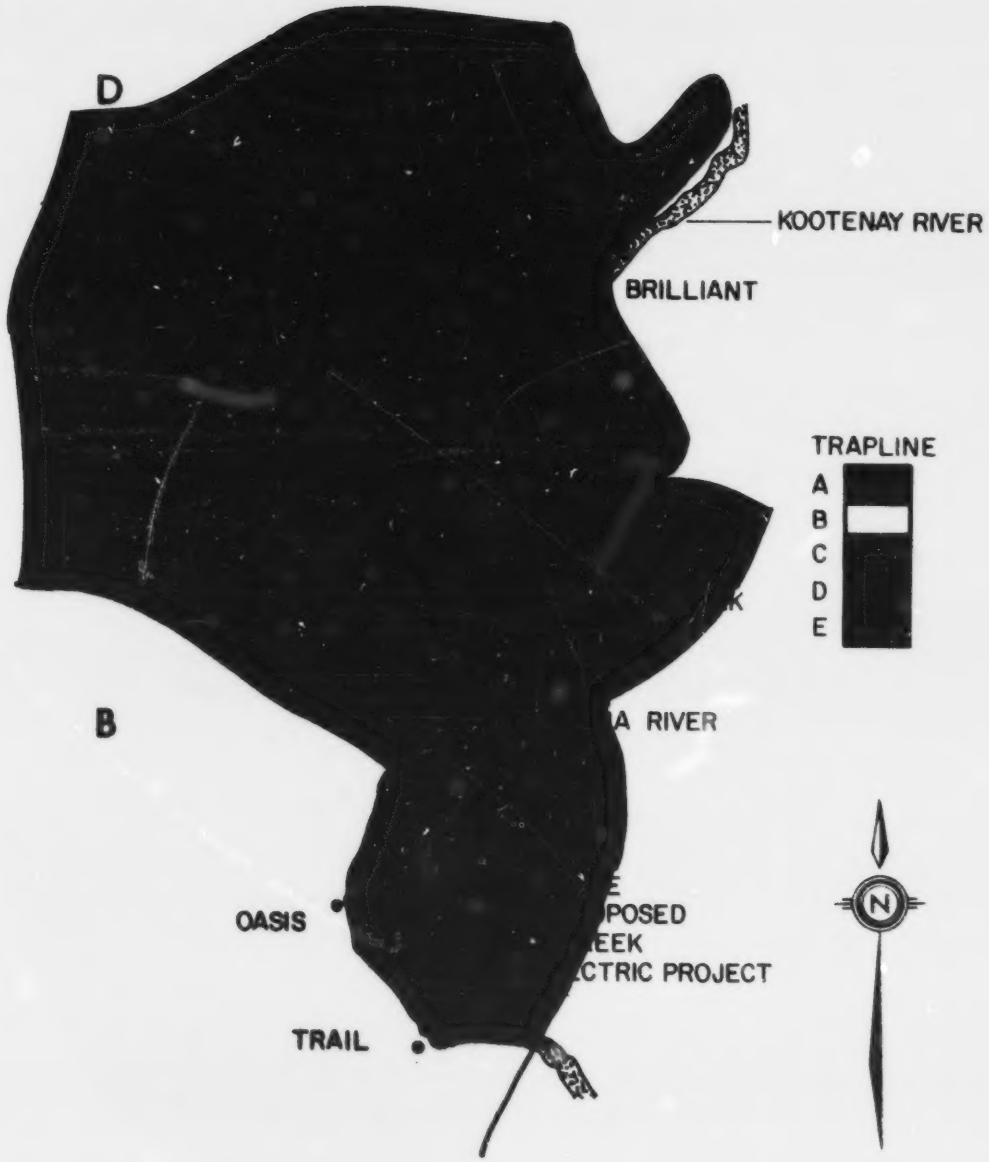


TABLE 5: Furbearer Trap-Harvest Records[1] for Registered Traplines[2] in the Vicinity of the Proposed Murphy Creek Project

Harvested Species[3]	Trapline A							Trapline B							Trapline C							Trapline D							Trapline E							Σ	n	Annual Average[5]
	Year of Record[4]																																					
	79	78	77	76	73	72	70	79	78	77	76	74	73	70	79	78	77	76	74	73	70	79	78	77	76	73	72	70	79	78	77	76	74	73	70			
American Beaver	1	1	-	1	-	10	10	28	30	34	22	2	10	38	22	1	7	17	4	2	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	241	21	11.48
Bobcat	-	-	-	-	-	1	-	-	1	-	-	-	-	3	1	-	-	-	-	-	2	2	1	-	6	4	-	6	-	-	-	4	-	-	-	31[5]	28	1.00
Coyote	3	2	2	4	-	3	-	2	1	-	-	2	2	2	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	2	-	-	3	-	-	31	28	1.11
Lynx	-	2	1	-	-	2	2	3	1	2	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	2	-	7	3	5	6	1	1	6	44	28	1.57
Marten	-	2	12	-	1	-	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	5	7	4	-	-	-	-	4	5	2	-	3	4	-	52	28	1.86
Mink	1	2	-	2	1	-	-	1	5	-	1	-	3	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	24[5]	28	0.82
Muskrat	-	1	-	-	-	-	-	3	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	10	-	-	-	24	28	0.86
Otter	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	28	0.11
Raccoon	1	1	-	-	-	-	-	3	1	-	-	3	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	18	28	0.64
Red Squirrel	-	-	-	-	-	19	19	38	1	-	-	1	5	5	10	-	-	-	-	-	-	36	1	9	4	2	1	30	35	5	32	25	4	6	2	300	35	8.57
Weasel (ermine)	2	2	-	-	-	1	1	6	5	1	-	-	-	-	-	-	-	-	-	-	-	8	4	13	-	-	-	6	6	1	12	6	3	2	1	80	28	2.86
Red Fox	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	28	0.07
Skunk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1[5]	28	0.00

1 Source: Fish & Wildlife Dept. files, Nelson, B.C.
2 Locations of these traplines are provided in Figure 10.
3 Scientific nomenclature is provided in Appendix 2.
4 Those years for which no data are available are deleted.
5 Annual average calculations do not include Traplines D and E for American beaver, and Trapline C for all species explains the variable number of years (n) upon which the average is calculated and the exclusion of bobcat, mink and skunk from Trapline C in this calculation.

TABLE 6: Proportional Contribution of Furbearer Species to Annual Harvest

Species	Average Annual Catch	Average Price/Pelt (1977-80)	Proportional Contribution (%)
American Beaver	11.48	31.30	28.4
Bobcat	1.00	222.76	17.6
Coyote	1.11	62.60	5.5
Lynx	1.57	303.93	37.7
Marten	1.86	28.99	4.3
Mink	0.82	26.01	1.7
Muskrat	0.86	5.64	0.4
Otter	0.11	77.11	0.7
Raccoon	0.64	31.50	1.6
Red Squirrel	8.57	1.86	1.3
Weasel (ermine)	2.86	1.93	0.4
Red Fox	0.07	75.52	0.4

1 Data from Mr. B. Saunders, pers. comm., 1981, Provincial Fur Management Biologist, B.C., from Statistics Canada information.

on the relative value of these traplines because they have been inactive during some years.

1. Trapline A includes lands along east and west banks of the Columbia River between Blueberry Creek and a point midway between Genelle and Oasis (near Sullivan Creek). The latest year for which data are available shows that, during the 1979 trapping season, the harvest for this trapline was 3 coyotes[1], 2 weasels, and one each of beaver, mink and raccoon (Table 5), totalling $365.53 (based on average provincial pelt values for that year). The major proportion of income from this trapline is from terrestrial rather than aquatic species, although Trapper A (pers. comm., 1981) related that he does trap for riverine species, primarily in the vicinity of Champion Creek, south to Birchbank. In addition, he traps coyotes utilizing sandy beaches along the river between Murphy Creek Bluff to a point approximately one mile above Blueberry Creek.

2. Trapline B is on the west side of the Columbia River from Sullivan Creek south. Trap records for the past several years indicate that Trapper B specializes in beaver trapping, although pelts of the higher priced terrestrial furbearers such as lynx and coyote are also taken. Most of this catch has not been from the study area, although complaints of beaver activity have occasionally encouraged him to trap problem animals in Sullivan, Murphy and McNally Creeks. Discussions with Trapper B (pers. comm., 1981) suggested that he felt the Columbia River portion of his trapline has poor trapping potential.

3. Trapline C includes the general area around Pass Creek, the lower Kootenay River (south side) to McPhee Creek, then along the north side of the Kootenay River from Thrums to the Slocan River (Figure 10). Trapper C, as does Trapper B, directs most of his trapping effort to beaver, with other furbearer species contributing a small proportion to his total fur harvest.

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1 Scientific names are provided in Appendix 2.

4. The north shore of the Lower Arrow Lake and Columbia River (between Castlegar and Cayuss Creek) follows the northern boundary of the trapline run by Trapper D (Figure 10). Harvests from this trapline reflect an apparently exclusive effort toward terrestrial species. No aquatic furbearer harvest has been recorded for this trapline over the past ten year period.

5. Trapline E abutts the study area along the south shore of the southeast portion of the Lower Arrow Lake, between the Castlegar-Robson ferry and the Hugh Keenleyside Dam. Records for this trapline are similar to those of Trapper D in that the harvest data show a distinct preference for terrestrial pelt harvest.

4.2.2 Abundance, Distribution and Habitat Considerations

The proposed development would affect primarily aquatic furbearers, of which beaver is locally the most economically important. Much of the biology of beavers is well known and it is widely recognized that their survival is highly dependent on two critical factors: water level integrity (to avoid inundation of dens or lodges) and availability of preferred deciduous vegetation (their primary forage). Beaver tend not to use large waterbodies with shorelines prone to heavy wave action (Dennington & Johnson, 1974), streams greater than 15.24 m (50 ft.) in width, or moving water with a gradient of greater than nine percent (Thomasson, no date). Food consists primarily of aspen, willow and alder, and reports suggest that these preferred species must be within 183 - 366 m (200 -400 yards) of aquatic habitat to show any utilization by beaver (Dennington et al., 1973; Thomasson, no date). On the basis of this information it is clear that the study area is relatively poor beaver habitat, and this has been confirmed by interviews (F. Salekin, G. Worobey, G. Erikson, pers. comm.).

Local confirmation of the effect of fluctuating water levels on traplines is evident from discussions with Trapper C (pers. comm., 1981), who noted that one of the limitations to beaver trapping in the Brilliant - Kootenay Reservoir is its water level instability; he sets his traps under water and often returns to find them well above the water line.

Estimates of numbers of beaver are crude and rely heavily upon the information provided by trappers. In the upper part of the study area, that part which includes Traplines C and E (from Blueberry Creek upstream to the dams), these trappers estimated a beaver population of 35-40 which includes at least two lodges. Based on conversations with Trappers A and B the southern portion of the study area supports much fewer beaver. Considering the general absence of slack or slow-moving water in this area, there may be no permanent population in this area, as suggested by Trapper B. There is no basis for estimating a population of beaver greater than 10 for this reach of the river.

Other aquatic furbearers exist in the study area, although none appear to be exploited heavily. Muskrat habitat is poor in the Columbia River, lacking areas of extensive aquatic forage. As is the case with beaver, muskrat are also highly dependent on stable water levels, since fluctuations disrupt necessary aquatic flora and may result in inundation of dens or houses (Sather, 1958).

River otter occur in the study area, however few are trapped (3 since 1975). Trappers report that otter have come into the north end of this study area since the late 1960's, but this area is not being actively trapped for aquatic furbearers.

Mink contribute little to the fur harvests of the traplines in the study area. Because mink are not as strictly dependent on aquatic habitat as beaver, muskrat or otter, they will be influenced less by water level fluctuations than the above species.

4.3 Birds

4.3.1 Aquatic Birds

The Columbia River from Oasis upstream to the Hugh Keenleyside and Brilliant Dams is utilized by a relatively small number, but widely diverse community of

aquatic birds. Although the emphasis of this section is on waterfowl[1] (31 species recorded in the West Kootenay Region of British Columbia), other birds of the area are divers[2] (9 species), herons and bitterns (2 species), rails and coots (3 species), shorebirds (20 species), gulls, terns and jaegers (12 species) osprey, bald eagle and kingfisher. Starting from this broad resource the goal of the study methodology was to narrow the perspective to the significant issues. As part of this process three aerial surveys of the study area and adjacent reservoirs were conducted, recent bird sightings (chiefly 1968-1975) were compiled by W.J. Merilees, mostly his own observations, and an assessment of the broad habitat requirements of the chief species was undertaken.

In general, the number of waterfowl which regularly reside in the study area is small, numbering not more than a few hundred individuals. Of the 31 species of waterfowl recorded for the West Kootenay Region, 28 have been sighted on the Columbia River from Oasis to the Brilliant and Hugh Keenleyside dams. When compared with the Kootenay Valley at Creston, where approximately 68,000 waterfowl pass north each spring and approximately 93,200 pass southward each fall (Brian Stushnoff, pers. comm.) the Columbia Valley between Trail and Castlegar is not a significant area for waterfowl. Because the study area is generally unsuited to feeding, except for mergansers and some duck species, most waterfowl are transients. These individuals stop to rest for a short time before moving on, so the passage of these migrants is particularly pronounced, especially in spring. No more than a few thousand individuals pass through each spring and fall and most sightings are of the magnitude of a few dozen.

Other than waterfowl, only the shorebirds, particularly spotted sandpiper, and the large gulls occurred in sufficient numbers to warrant special attention here. Osprey nest within the study area and are a species of considerable conservation interest (Section 4.3.2).

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1 Scientific names are provided in Appendix 2.
2 Divers are defined here as loons, grebes and cormorants.

Aquatic birds are considered under three broad categories. First, seasonal distribution and abundance addresses all the information pertinent to the study area, plus a consideration of the adjacent reservoirs. Distribution and abundance are discussed primarily on the basis of surveys and highlight general points; occurrence is based primarily on earlier records and is presented on a species basis. The discussion of habitat requirements addresses in a general way the chief features of the study area attractive to birds, and compares this to the likely habitats within a Murphy Creek Dam reservoir. Lastly, consumptive and non-consumptive utilization of waterfowl in the study area is considered.

Seasonal Distribution and Abundance

Aerial surveys of the study area indicated that relatively few bird species utilize the river, and that numbers, while generally low, appeared be relatively constant throughout the year (Table 7).

The principal species in the study area in summer were mallard, common merganser, spotted sandpiper and unidentified gulls (Table 7). Based on the records of W.J. Merilees and observations during this study, these are largely herring gulls, California gulls and ring-billed gulls. None of these species are known to nest near the study area, but mallards and common mergansers are breeders in the study area and several broods were observed (Table 8). Spotted sandpipers were common along the river banks during the breeding survey, and the study area is undoubtedly a locally important production area for them.

TABLE 7: Aerial Surveys of Aquatic Birds in Three Reaches of the Columbia - Kootenay River System

	Columbia & Kootenay Rivers: Oasis to Hugh Keenleyside & Brilliant Dams			Kootenay River Reservoir: Brilliant Dam to Slocan Pool			Arrow Lake: Hugh Keenleyside Dam to Deer Park		
	May 30 1980	October 10 1980	March 26 1981	May 30 1980	October 10 1980	March 26 1981	May 30 1980	October 10 1980	March 26 1981
Red-Necked Grebe[1]	-	-	-	-	-		2	-	-
Horned Grebe	-	-	-	-	-	-	-	-	32
Eared Grebe	-	-	-	-	-	-	-	2	-
Western Grebe	1	3	-	-	5	-	-	28	-
Canada Goose	11	-	6	45	109	45	-	-	-
Mallard	34[2]	121	27	23	95	28	1	71	8
Gadwall	-	-	-	1	-	-	-	-	-
Pintail	-	-	-	-	-	-	-	-	5
Green-winged Teal	-	-	-	2	-	-	-	-	-
Blue-winged Teal	44	-	-	17	-	-	20	-	-
American Wigeon	-	6	16	-	223	49	-	13	18
Northern Shoveler	2	-	-	-	-	-	-	-	-
Ring-necked Duck	1	-	-	-	-	10	-	-	-
Canvasback	5	-	-	-	-	-	-	-	-
Scaup sp.	-	2	5	-	92	-	-	6	-
Common Goldeneye	-	-	39	-	-	63	-	-	11
Barrow's Goldeneye	8	-	28	-	-	-	-	-	-
Goldeneye sp.	-	-	-	2	8	-	-	-	-
Bufflehead	-	-	38	-	3	26	-	12	8
White-winged Scoter	2	-	-	-	-	-	-	10	-
Hooded Merganser	-	2	-	-	-	-	-	-	-
Common Merganser	91[2]	23	72	16	-	6	6	10	15
Red-breasted Merganser	-	-	1	-	-	-	-	-	-
Ruddy Duck	-	1	-	-	-	-	-	-	-
Unidentified Duck	2	10	-	-	2	-	-	-	-
Unidentified Diver	-	-	2	-	-	4	-	6	3
American Coot	1	-	-	-	-	-	-	-	-
Killdeer	7	12	-	-	2	4	3	2	-
Spotted Sandpiper	82	-	-	18	-	-	10	-	-
California Gull	-	3	-	-	-	-	-	-	-
Ring-billed Gull	-	-	-	-	-	-	-	1	-
Bonaparte's Gull	5	-	-	-	-	-	-	-	-
Unidentified Gull	31	63	43	-	6	-	1	33	2
Osprey	4	-	-	1	-	-	3	-	-
Bald Eagle	-	-	1	-	-	-	-	-	-
Great Blue Heron	-	3	1	6	3	1	-	-	-
	351	255	281	131	548	236	48	194	102
Total Length of River (km)		34			17			22.5	
Aquatic birds/ linear km	10.3	7.5	8.3	7.7	32.2	13.9	2.1	8.6	4.5

[1] Common names follow the nomenclature of the A.O.U. (1973).
[2] Includes young of the year.

TABLE 8: Waterfowl Broods Observed during this Study, May 1980

Species	Number	Date	Site
Mallard	1 F + 7	May 30	Castlegar-Robson Ferry
Common Merganser	2 F + 20	May 30	Genelle Sand Bars
	1 F + 8	May 31	2 km downstream of Champion Creek
	1 F + 12		Unknown - Record lost

In autumn, as indicated by the October 10 aerial survey there was some change in the species and group composition (Table 7; Figure 11). Numbers of shorebirds had decreased (owing to the departure of spotted sandpipers), and numbers of common mergansers had dropped by two thirds. Numbers of puddle ducks and gulls increased. The October 10 survey date appeared to have preceeded the influx of diving ducks.

The aquatic bird community in winter was only partially surveyed, during the March 26 survey, owing to the lateness of the season. Results of an earlier survey of February 25 were lost in a fire. Nevertheless, the later survey recorded the preponderant number of diving ducks which winter in the study area (Figure 11).

These results also indicated an increase in numbers of mergansers compared to the October 10 survey. Numbers of puddle ducks and gulls were down.

Accounts of species distribution, abundance and their timetable of migration through the study area is presented below. The following terms are used: permanent resident - present all year round; seasonal resident - present for one or more season, but absent for at least part of the year; transient (migrant) - present only during migration.

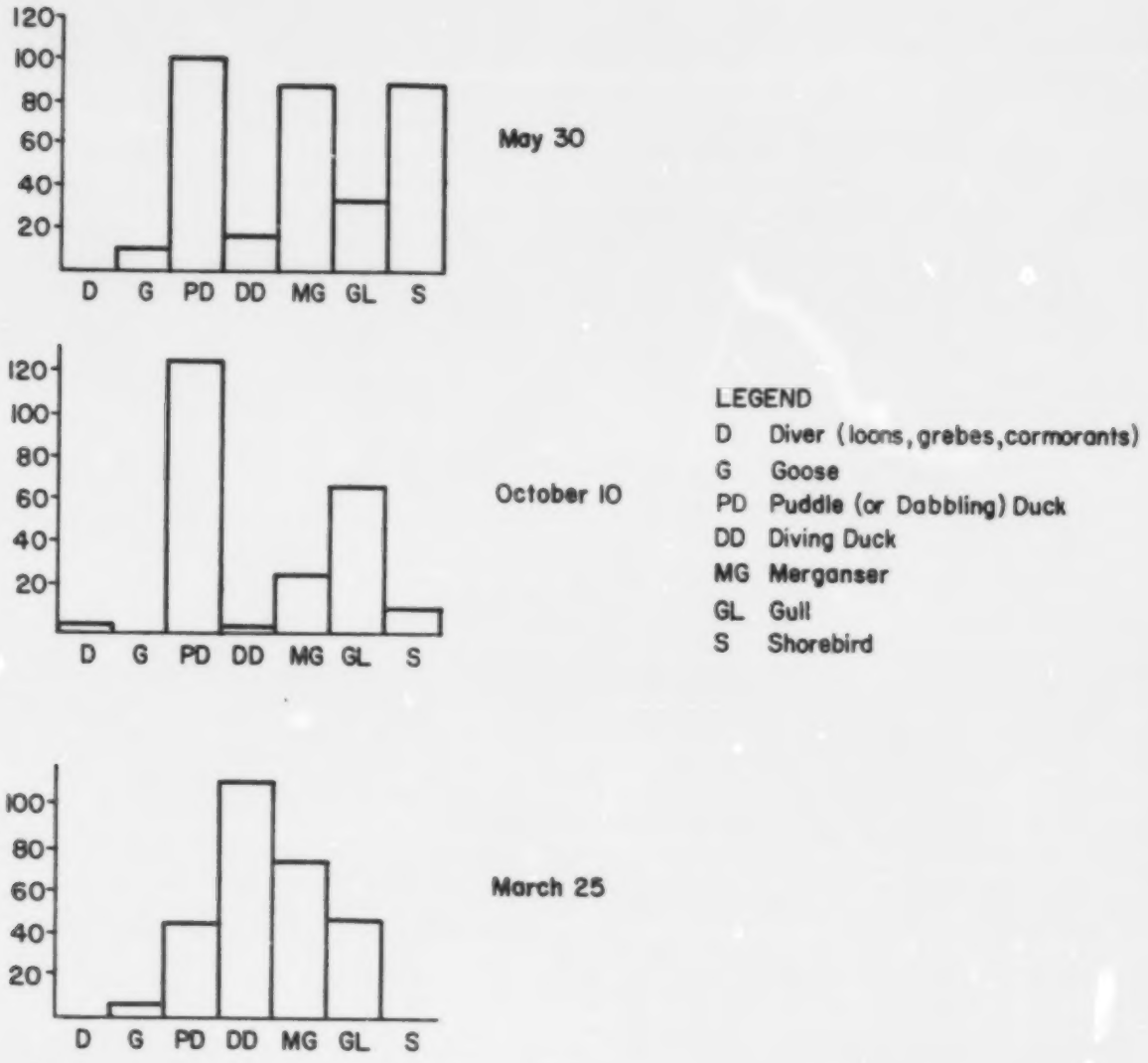


FIGURE 11 : Comparative Numbers Of Different Aquatic Bird Groups At Three Periods Along The Columbia-Kootenay River Study Area (1980-81).

SPECIES LIST:

Common Loon: The common loon is observed sporadically in the study area from early October until late May (Figure 12). There are two summer records, one in early July and one in later August. A small influx of migrating birds appears during late April and early May and again in late October. The common loon breeds on small lakes in the West Kootenay Region.

Arctic Loon: There are only six records for this species in the study area from early October until late November. This species is not recorded every year.

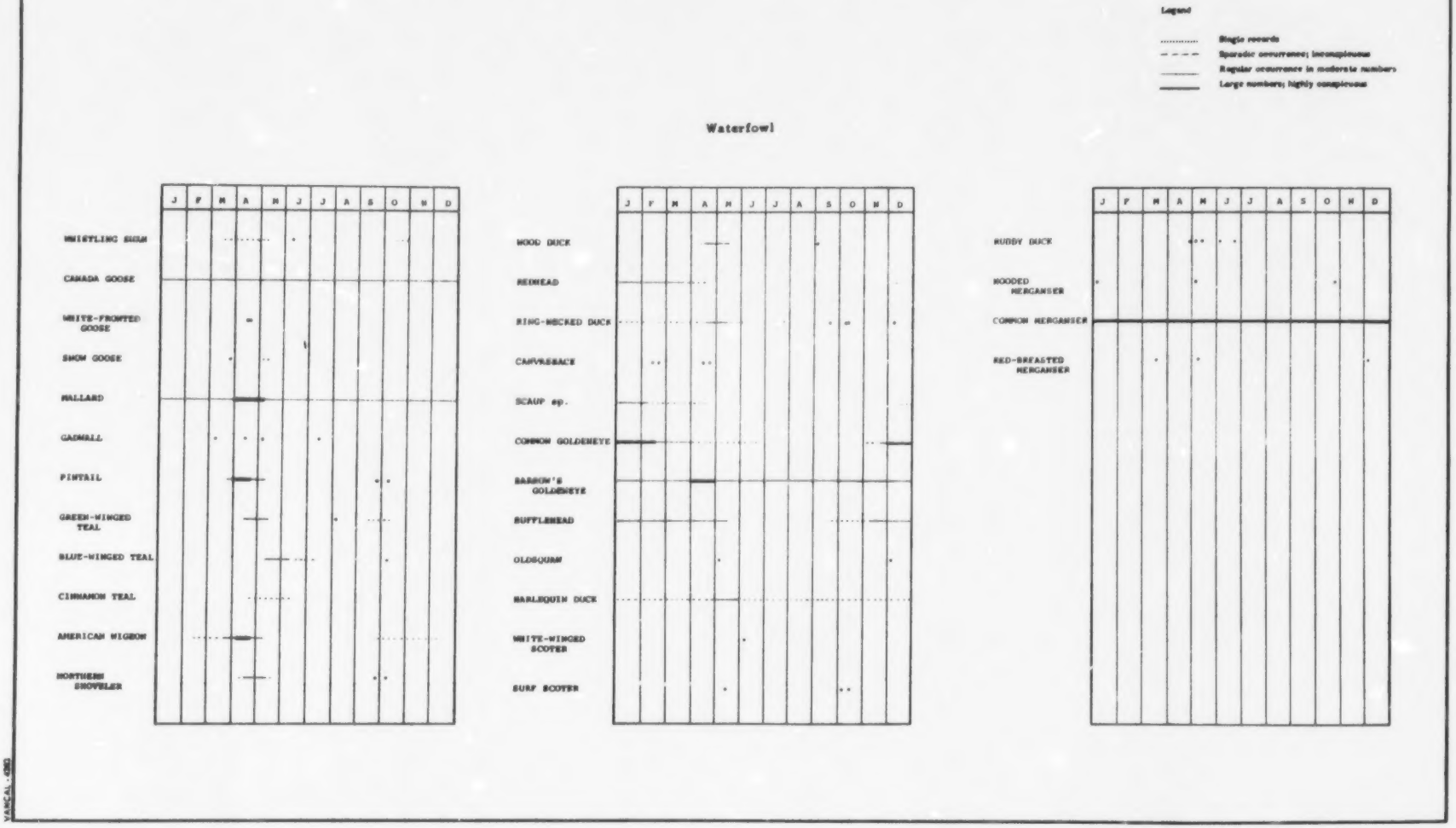
Red-necked Grebe: Although the red-necked grebe is known to nest at Duck Lake near Creston this species is recorded in the study area only as a transient between late April and early June. Less frequently it occurs in fall between late August until mid-November (Figure 12).

Horned Grebe: The horned grebe is a winter resident and a transient in the West Kootenay Region. In the study area it is known to occur occasionally from January until late June and occasionally from mid-October until mid-November (Figure 12). During late April until early May there is a pronounced influx of migrating individuals.

Eared Grebe: There are only four records of eared grebes in the study area, one in early February, one in early May, and two in September indicating that small numbers of this species pass through the area on migration.

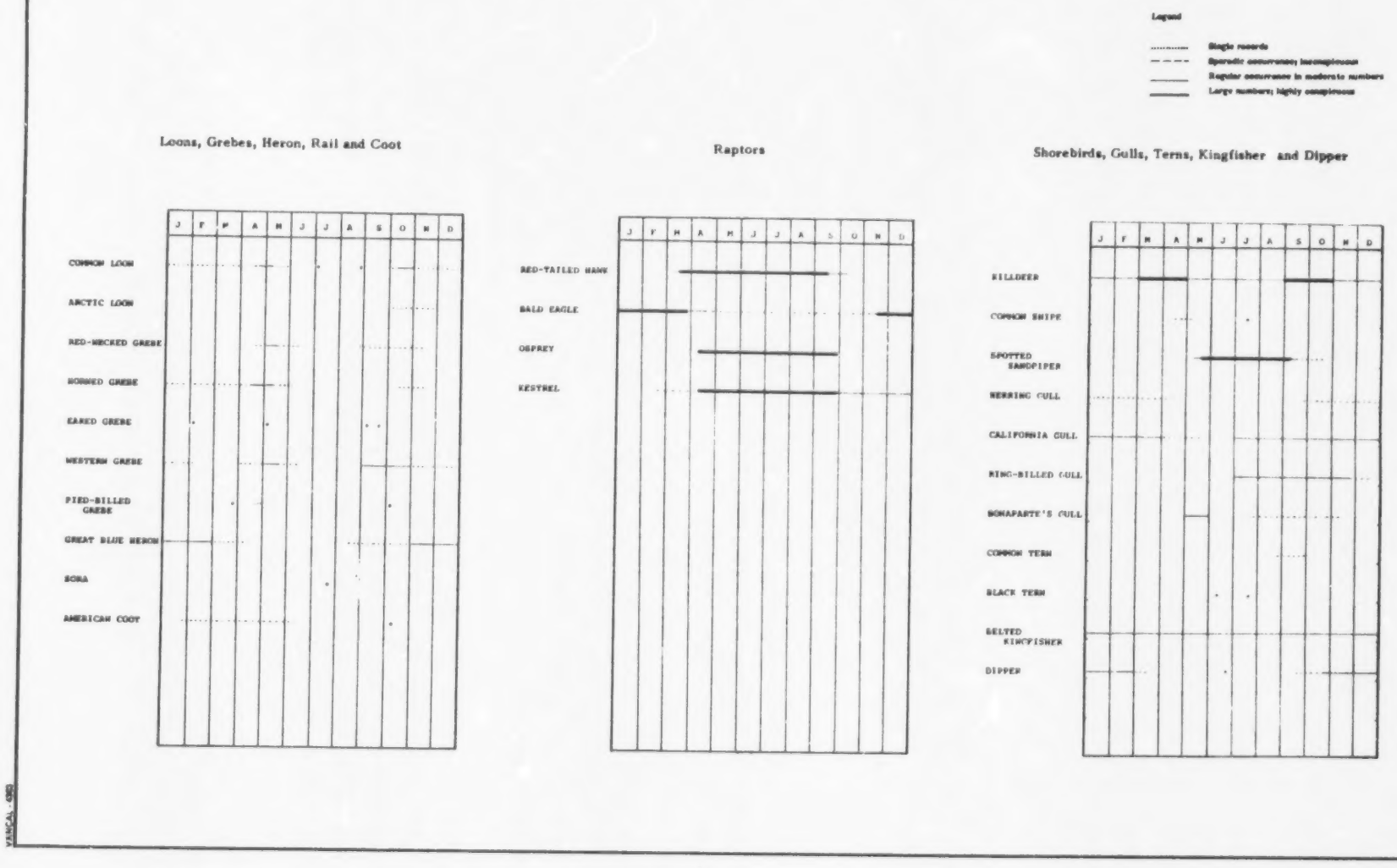
Western Grebe: The western grebe is the most numerous grebe species in the West Kootenay Region. It is a winter resident on the West Arm of Kootenay Lake but in the study area it is recorded infrequently. At times large numbers settle on large lakes in the region particularly during early May. In the study area western grebes are present regularly during early May and during September and October. Between early November and early February, during April and from late May until early June they are recorded occasionally (Figure 12).

FIGURE 12a: SEASONAL OCCURRENCE OF AQUATIC BIRDS IN THE STUDY AREA (From W.J. Merrilees, unpublished data)



YAKCAL-080

FIGURE 12b: SEASONAL OCCURRENCE OF AQUATIC BIRDS IN THE STUDY AREA (From W.J. Merrilees, unpublished data)



Pied-billed Grebe: The pied-billed grebe is recorded in the study area only on an occasional basis. Of the seven records, five are in late April, one is in late March and one is in early October.

Great Blue Heron: The great blue heron is a year round resident of the West Kootenay Region but a resident in the study area only from late August until early April (Figure 12). Although a small breeding colony is located near South Slocan these birds do not appear to forage as far as the study area.

Whistling Swan: This species appears each spring in small numbers in the study area, particularly on the Kootenay River oxbow below Selkirk College. On one occasion 127 individuals in one flock rested briefly in this area. In total there are thirteen records for this species, nine between late March and early June, primarily in April, and four records in mid to late October (Figure 12). About 1,000 individuals of this highly attractive species pass through the Creston Valley each spring and about 200 each fall (Brian Stushnoff, pers. comm.).

Trumpeter Swan: There are no records of this species for the study area though it has been reliably recorded on five occasions in nearby areas from early January to early June. The identification of this species by sight alone is not easy, but this species can be expected to occur in the study area on a casual basis.

Canada Goose: The Canada goose is a resident species in the region with flocks of up to 100 individuals being recorded on occasion. In keeping with other Canada goose populations in British Columbia, the West Kootenay population appears to have increased from 1968 to 1977 and may still be increasing. Breeding has not been recorded in the study area and no broods were observed during the May 30 survey, at which time broods should have appeared. Some migratory populations pass through the area as the observations peak in April and again in September to early October. The population in the greater Castlegar Area appears to be about 50 individuals that range quite widely along the two rivers, particularly the Kootenay from Thrums to Shoreacres, above the Brilliant Dam (Table 7).

White-fronted Goose: Only two records of this species, both in mid April, are known for the study area. On the basis of these records this species can be expected to occur on a casual basis as lone individuals or as small flocks.

Snow Goose: Only three records are known for the study area, one in late March and two in mid May. The May records are of two individuals which were present on the Columbia River near the mouth of the Champion Creek for at least seven days from May 8 to 15, 1971.

Mallard: Historical records indicate the mallard is a resident species in small numbers and a regular transient through the area in April and early to mid-May. Mallards also pass through the study area in small numbers during September. A few pair breed in the area, usually close to small permanent ponds away from the main river where food is more readily available for their young. During our study, one mallard hen was observed nesting in Pass Creek Regional Park (W.G. Biggs, pers. comm.), and one brood was observed near the Castlegar-Robson Ferry (Table 8). Both these areas are upstream of the Columbia-Kootenay River confluence on the Columbia River, and within close proximity to the Castlegar sewage lagoons. This was the principal mallard concentration site along the study area. The numbers recorded on May 30, when mallard broods should be starting to appear, encourages the view that considerable productivity takes place and would have been recorded had surveys taken place several weeks later. The 121 mallards observed in the October 10 survey indicate the value of the study area as a stopping off place for this species.

Gadwall: The gadwall is an irregular transient through the study area. Only four observations have been made, one each in the months of March, April, May and July. In other parts of the West Kootenay this pattern is similar although records are available for January and February as well. There are no fall records for this species. Only one gadwall was recorded in this study (Table 7).

Pintail: Small numbers of transient pintail are seen in the study area each spring between late March and early May. There are only two records for this species in the fall, one in late September and one in early October. The spring transient

population is about 100 individuals. The one observation during our study, 5 observed on March 26, 1981 on Arrow Lake is consistent with historical records.

Green-winged Teal: The green-winged teal is a regular spring transient in small numbers from mid-April to early May, and a fairly irregular fall transient during September until mid-October. There is one record for early August but no indications of breeding in the study area. Green-winged teal were observed only once during our study, but the survey periods tended to miss periods of green-winged teal occurrence.

Blue-winged Teal: Blue-winged teal are regular migrants through the area from mid-May until early June. In some years they are present in considerable numbers. There are two records for mid-July which may indicate breeding, however no young have been seen. There is only one fall record during early October. Those recorded during the May 30 surveys no doubt reflect the late spring movement of this species through the study area.

Cinnamon Teal: Cinnamon teal are fairly regular spring transients through the study area from late April until mid-June. There are no records for other times of the year.

European Wigeon: This species has not been recorded in the study area though there are two records for the Nelson area of birds present from late October until late December. It is possible that this species will be recorded at some future date in the study area.

American Wigeon: This species is a common winter resident and an uncommon summer resident of the West Kootenay Region. It prefers the reservoir above the Brilliant Dam and along the West Arm of Kootenay Lake where there is a good aquatic weed growth. In the study area transient birds are recorded between mid-February and early May, particularly during April. There are a few records between late September and early December.

In this study, the findings confirm parts of the historical record, i.e. spring migration is over by early May for American wigeons, and they are relatively common winter residents. However sightings in autumn, particularly the 223 observed above the Brilliant Dam, indicate unusual abundance. In general, the small numbers in the proposed reservoir area indicate relatively poor habitat characteristics.

Northern Shoveler: The northern shoveler is a regular spring transient from mid-April until mid-May. There are only two fall records, one for late September and one for early October. This species was recorded only once in this study.

Wood Duck: The wood duck is a regular summer resident in the West Kootenay Region where suitable habitat occurs. In the study area it is an irregular transient recorded in spring between mid-April and mid-May. There is one fall record for early September. None was observed during our study.

Redhead: The redhead is a transient and winter resident of the West Kootenay Region. In the study area there are scattered records from mid-December until late April. One redhead was observed during the May 29 - June 2 study period.

Ring-necked Duck: Ring-necked ducks are infrequent residents of the West Kootenay Region from mid-December until early June. They may be seen in the study area during this time, particularly during late April and early May (Figure 12). One ring-necked duck was observed near the Cancel mill on May 30, and a flock of 10 in the Slocan Pool on March 26 (Table 7). Though the precise record has been lost, over 40 were observed in this area during the February 25 survey.

Canvasback: The canvasback is a transient and winter resident of the West Kootenay Region. It is present from early October until late April. In the study area it has been recorded only four times, twice in mid-February and twice in late April. The five canvasbacks observed on May 30 (3 males, 2 females), represents a late sighting away from preferred breeding habitat, and may involve non-breeders.

Greater Scaup: Separation of the two scaup species is difficult due to their close similarity. Careful observations indicate that a large majority of the scaup present in the West Kootenay Area are greater scaup. These individuals are transients and winter residents from early October until early May. In the study area small numbers of this species are present from mid-December until late April, particularly during January and early February. Only seven scaup (species not confirmed) were observed in the study area during our investigations. Ninety-two were observed in the adjacent reservoir above the Brilliant Dam in October (Table 7).

Lesser Scaup: Lesser scaup, apparently transients in the West Kootenay area, were identified with certainty on only five occasions; once in mid-February, twice in September and twice in early to mid-December. While there are no records for the study area, this species can be expected to occur as a transient in small numbers, particularly during the fall.

Common Goldeneye: The common goldeneye is a winter resident present in considerable numbers from mid-November until mid-March and recorded sporadically thereafter until mid-June. Small groups of common goldeneye can be encountered along the Columbia and Kootenay Rivers with as many as 200 individuals being present in the study area on occasion. Results of our surveys conducted indicated peak occurrence is in winter (Table 7) and that the principal concentration sites for these and other diving ducks are upstream of Waterloo Eddy (Table 9).

Barrow's Goldeneye: Barrow's goldeneye are year round residents of the West Kootenay Region but are regularly recorded on the Columbia River only from early November until early June, particularly during April (Figure 12). At times, loose flocks of up to 125 individuals can be encountered. The species breeds in the Columbia Valley alongside beaver ponds at the Castlegar Outdoor Education Area. During the summer months female and subadult male goldeneye are virtually impossible to separate to species. All summer records are attributed to this species. Only Barrow's goldeneye were observed during this survey in late spring. In winter they occurred only in the study area in preference to the adjacent

TABLE 9: Distribution of Aquatic Bird Groups in Different Sections of the Study Area

		30 May 1980		26 March 1981	
1.	Oasis to Sullivan Creek	PD-9 MG-12	S-18	PD-9 MG-13	G-6
2.	Genelle Gravel Bars to Champion Creek	PD-6 DD-3 MG-23	S-21 D-1	PD-3 DD-5 MG-11	GL-1
3.	Champion Creek to Waterloo Eddy (incl)	PD-37 MG-14	S-15 Coot-1	PD-4 MG-18	GL-30
4.	Waterloo Eddy to Columbia-Kootenay R. confluence	PD-1 MG-17 S-18		DD-26 MG-28	GL-2
5.	Columbia-Kootenay River confluence to Brilliant Dam	MG-12 S-3 O-1		DD-22 MG-3	
6.	Columbia-Kootenay confluence to Hugh Keenleyside Dam	PD-47 DD-13 MG-13	G-10 GL-36 O-3 S-13	PD-27 DD-58 MG-3	GL-12
7.	Castlegar Sewage Lagoons	PD-40 (est) Coot-4		PD-18 DD-44	

LEGEND

D Diver (loons, grebes)
G Goose
PD Puddle (or Dabbling) Duck
DD Diving Duck
MG Merganser
GL Gull
S Shorebird
O Osprey

reservoirs and were most conspicuous upstream of the Highway 3 Bridge, i.e. above the Waterloo Eddy.

Bufflehead: This species is present in the study area from late September until mid-May in small numbers, a close reflection of this species' status in the Region. The possibility clearly exists that this species breeds in the area but this has not been substantiated. No bufflehead were observed during the breeding season survey (May 30). They were relatively common in winter, and like Barrow's goldeneye were more numerous in the study area than on adjacent reservoirs.

Oldsquaw: The oldsquaw is a scarce but regular transient in the West Kootenay Region. There are only two records for the study area, one in early May and one in early December.

Harlequin Duck: Harlequin ducks have been recorded in the study area during all months of the year, in very small numbers (Ellison and Merilees, 1980). The species undoubtedly breeds along tributary streams in the region, but no records are available for the study area. There is a peak in observations during May indicating the arrival of birds from the coast.

White-winged Scoter: This is an uncommon transient species in the West Kootenay Region. There are only five records for the Region. The only previous record for the study area is for early June and the May 30 sighting in this study is consistant (Table 7).

Surf Scoter: The surf scoter is as uncommon as the preceding species; only five records are available for the Region. Three of these, two in early to mid-October and one for mid-May, are for the study area.

Ruddy Duck: Ruddy ducks are uncommon transients through the West Kootenay Region. In the study area they have been recorded five times between late April and late June. Though there are no fall records for the study area there are a number of records from mid-August to mid-December for the region. In this study

one ruddy duck was observed during the May 29 - June 2 study period, and another during the October 10 survey.

Hooded Merganser: The hooded merganser is a resident species in the Region, being fairly common in winter and uncommon in summer. Owing to an absence of suitable habitat there are only three records in the study area, one each in January, May and October. Two were observed during the October 10 survey.

Common Merganser: Second to the mallard, the common merganser is the most numerous resident waterfowl species in the study area. Though regularly recorded in all months, historical records show it is most numerous during the late fall to early spring period. Our surveys contradicted this result by showing a high in late May. The population is believed to be about 100 individuals. The species breeds in the area with young appearing off their nests as early as May 30. Four broods were observed during this study (Table 8). Large Cottonwood trees along the river are important nesting sites for this species. In contrast to the puddle ducks and diving ducks, the common merganser does not tend to concentrate in those reaches of the study area with the slowest flows, i.e. on the Columbia River above the confluence with the Kootenay River. During the breeding season merganser concentrations were relatively uniform throughout the length of the study area (Table 9). Numbers of common mergansers in the adjacent reservoirs were much lower during all survey periods.

Red-breasted Merganser: This species is a regular but uncommon winter resident in the West Kootenay Region from early December until late March. There are only three records for the study area; one in mid-March, one in mid-May and one in early December. One red-breasted merganser was observed during the March 26 survey.

American Coot: The American coot is a common winter resident of the West Kootenay Region but is seen infrequently during the summer months due primarily to unsuitable breeding habitat. In the study area coots have been recorded from late January until early June and once in early mid-October. The Castlegar sewage

treatment ponds provide the best area for this species and breeding at this location has been observed.

Killdeer: Killdeer are resident in the study area all year but are recorded in very small numbers during the winter months. During March and April and September and October their population increases with migrating individuals. This species breeds in the study area on benches, gravel bars and open fields where open ground and sparse vegetation exist.

Common Snipe: Because there is virtually no habitat suitable for this species in the study area, except when the river is receding after the spring freshet, this species has not been recorded regularly. In the West Kootenay Region it is a resident breeding species in small numbers. The records during April and May are migrating birds.

Spotted Sandpiper: The spotted sandpiper is the most numerous shorebird found in the study area. This species arrives in mid May and remains a common species until early September. Early arrivals and stragglers extend the presence of this species from early May until mid-October. This species breeds on riverbanks, gravel bars and slopes and fields adjacent to the river. At the present time nesting occurs when the Columbia River is nearing its highest level. Egg laying commences in early June with young appearing about three weeks later.

Herring Gull: In the West Kootenay Region the herring gull is a common winter resident with only a few individuals remaining during the other times of the year. In the study area small numbers have been recorded from late September until early April.

California Gull: The California gull is the most commonly encountered gull species in the study area. It is present in small numbers from early June until early April and fairly frequently from early April until late June.

Ring-billed Gull: The ring-billed gull is a summer visitor to the study area. The first arrive at the end of June and the last depart by late November. Occasionally one or two individuals are seen during the other times of the year.

Bonaparte's Gull: This species is a transient through the study area seen most frequently during May and occasionally from mid July until mid November.

Common Tern: The common tern is a transient species appearing in the study area from late August until the end of September. It is not recorded every year but when present is often seen in small flocks.

Black Tern: Though the black tern breeds at Creston there are only two records available for this species in the study area, one in mid-June and the other in mid-July. One was observed during the May 29-June 2 study period.

4.3.2 Terrestrial Birds

Raptors

The checklist of West Kootenay birds lists 15 species of raptors which occur in this area. However, based on specific records of their occurrence and habitat requirements, only three species are listed here. These are osprey and bald eagle, which are aquatic oriented, and the kestrel which commonly nests in tall riverbank cottonwoods.

Osprey

Historical records indicate that osprey appear in the study in early April and depart before the end of September. Most records occur in May and August. During the May 30 survey four osprey were observed (Table 7), and two traditional nest sites were confirmed. These nests occur on i) power lines which cross the Columbia River immediately upstream of its confluence with the Kootenay River, and ii) piles immediately adjacent to the B.C. Timber Pulp and Paper mill.

Bald Eagle

Bald eagle records in the study area peak from November to March, with few or no records from May to September. The study area clearly is a wintering area, but the average population occurring in the winter has not been estimated. One bald eagle was observed opposite Genelle during the March 26, 1981 aerial survey.

Kestrel

Kestrels appear in the study area in early April, are common breeders during the spring and summer after which numbers decline. A few kestrels are recorded as late as December. Their importance relative to the Murphy Creek project is that they commonly nest in cottonwoods along the banks of the Columbia River. They nest in other locations as well, but the deterioration of cottonwoods provides numerous nesting opportunities for hole-nesting species such as the kestrel.

Upland Game Birds

Upland game bird surveys were conducted with the aid of 2 pointing dogs (Brittany Spaniels) along the 7 transects used for browse and pellet group surveys and at the till site. The area searched by the dogs was approximately a one-half kilometer wide strip centering on the transect. The dogs searched about 50% of the area covered and presumably found 50% of the birds present.

The only area within the 500 meter study boundary in which upland game birds were found was in the Champion Creek lowland. Two adult ruffed grouse were located in separate locations along this transect, within a young lodgepole pine stand. These ruffed grouse likely rely on nearby forb and shrub communities for the majority of their food. Below the 500 m contour an estimated area of 20 hectares were surveyed for upland game. Extrapolating the two sightings to the entire study area (3,617 hectares, est.) and assuming the coverage (50%) and accuracy (50%) outlined in the previous paragraph, a population of approximately 1,440 individuals is estimated for the study area. The confidence we can put on

this estimate is low since the estimate is based on only two sightings. On the other hand, it is the only systematic data available.

The only other location at which ruffed grouse were found was in the Hanna Creek drainage above 500 m. Seven ruffed grouse, 2 adults and 5 juveniles were found in a deciduous forest area on the north side of Hanna Creek in an area once designated as a potential till site. The understory of this forest contained abundant forbs and berry producing shrubs which appeal to ruffed grouse. Two other adults were found adjacent to the trail between Oasis and the till site. The habitat at this location was similar to that of the till site.

These data plus information from the West Kootenay Naturalists Association indicate that in the study area, the ruffed grouse is the principal upland game bird. A few Franklin's grouse may be found in the few areas where coniferous forests extend below 500 m.

4.3.3 Consumptive and Non-consumptive Use

According to members of the Trail Wildlife Association, duck and goose hunting in the study area is negligible, but there is some hunting for ruffed grouse. Estimated harvests of ducks, geese and ruffed grouse in the four management units (M.U.) which occur in the study area confirm the comparative harvest of the avian groups by hunters in this part of the west Kootenays (Table 10). Clearly, ruffed grouse is the principal bird species harvested.

Evaluating the ruffed grouse harvest in the study area is a more speculative exercise. Members of the Trail Wildlife Association identified the benches above the Columbia River as offering the best local hunting opportunities. However, in spite of using dogs in surveys, few ruffed grouse were observed in this study in October 1980, two below the 500 m elevation and nine on or near the proposed Hanna Creek till site. The regular hunting conducted by the Trail Wildlife Association indicates a consistent if low level hunting effort for upland game, primarily at the southern end of the study area. Though it is unlikely that this effort would be maintained without some success, it is also unlikely that the

average annual harvest in the study area exceeds one hundred individuals, based on these data.

TABLE 10: Estimated Harvest of Ducks, Geese & Ruffed Grouse in M.U. 4-8, 4-9, 4-14 and 4-15 during the period 1976 - 1979

	1976	1977	1978	1979
Duck	870	263	246	270
Goose	182	13	72	0
Ruffed Grouse	6230	3866	6351	6596

Source: B.C. Fish and Wildlife Branch, Victoria

5.0 PROJECT IMPACTS

5.1 Impact Classification

The assessment of project impacts can frequently be obscured by poor terminology and failure to categorize impacts in a defined manner. Project characteristics considered in this evaluation include reservoir clearance, dam construction, reservoir flooding, water level fluctuations and operation among the direct sources of impact, alteration of aquatic resources (e.g. fish), access and climate among the indirect sources.

Potential impacts deriving from the Murphy Creek Project have been discussed first in terms of separate project activities or properties which could have some impact on the wildlife resources of the study area.

Specific impacts on wildlife are identified as positive or negative, depending upon whether the impact tends to increase or decrease growth, survival, reproductive success or general productivity of the affected resource. Impacts vary in terms of duration. Some are short-term, others are long-term, and no doubt many are difficult to classify. In this report short-term impacts are considered temporary and affect a few generations or cohorts. Long-term impacts may extend over many generations or simply have no definable time limit. Habitat lost in the reservoir would be considered a long-term impact. However, because there would be no time in future when this process might be reversed, the impact might best be defined as a permanent or residual impact. Certain impacts deriving from this project could have direct influence on wildlife resources. The most prominent of these were listed above (construction, project operation, etc.). Other influences on wildlife might be indirect, such as the possible decline of mergansers in response to reduced fish numbers or availability.

Finally, it is important to be able to distinguish major, moderate, minor or insignificant impacts. Major impacts are those which threaten i) the persistence of a resource, or ii) a population of rare/endangered species in a region. A moderate impact would not threaten the persistance of a resource, animal community or

population, but might significantly alter its numbers or distribution. An important property of major and moderate impacts is that they are easily measurable. A minor impact may be of equal severity to a moderate impact, but be measurable in only a very localized area or involve low numbers. An insignificant impact is one in which the effects of development on a particular population are not detectable.

5.2 Project Characteristics with Environmental Implications

Development and operation of a hydro-electric dam entails a number of definable physical disruptions and alterations with considerable impact potential. The chief project characteristics leading to possible impacts have been categorized under reservoir clearing, dam construction, reservoir filling and operation. Construction has been further narrowed to distinguish the dam site, till site and spoil site. Reservoir filling and operation includes water level, wind, access, reservoir fluctuation and railway relocation.

Reservoir Clearing

Trees in the proposed reservoir would be cut as part of the clearing process. Although shrub vegetation is left in this process, disturbance from the clearing process would discourage deer utilization in such areas prior to reservoir filling.

Construction

Dam Site: At all construction sites there would be considerable equipment and human activity and noise. At the dam site surface, features would be altered as part of local clearing, filling and equipment installation procedures.

Till Site: Approximately 22,000 m^3 of impervious till for the dam would be obtained from the Murphy Creek till site. This site is located at approximately 700 m contour in the Murphy Creek drainage. At this site there would be some temporary destruction of vegetation and additional disturbance associated with the haul road. Approximately 40 truck trips per day are expected during the 2 months

that the till borrow pit would be in use. In addition, a new access road to the till site would be constructed.

Spoil and Work areas: On both sides of the river, above and below the proposed dam site are a series of work and spoil areas. The most extensive of these are on the east side in areas with a habitat capability for ungulates estimated at low to moderate (Figure 9). On the west side such areas are smaller in extent. The use of these areas will temporarily alienate habitat which is estimated to be very low (Figure 9).

Railway Realignment: Based on a reservoir normal operating level of 424 m, Thurber Consultants (1983) has identified 5.4 km of track, located from km 27.6 to km 32.7 (river reference points) downstream from the Hugh Keenleyside Dam (including Birchbank siding and the Murphy Creek bridge) that would require relocation as a result of the proposed dam. Also, 0.75 km at the Murphy Creek dam site would require relocation.

Reservoir Filling and Operation

Water Level: The resulting reservoir would constitute the most conspicuous impact of the project. Full pool elevations of 424, 427 and 430 m were considered during the study. The 424 m level has been selected.

Wind: B.C. Hydro (1981b) has concluded that wind velocities would increase slightly, owing to increased water surface area. No quantification of this increase has been provided, but it is identified as being less than that caused by the flooding of the Arrow Lakes Reservoir.

Access: B.C. Hydro does not plan to provide vehicle access across the dam.

Water Level Fluctuation: B.C. Hydro (1982) has identified alternative operating regimes. Operating Regime 1, identified a draw down period extending from February to May. During this time the reservoir would be lowered to about 418 m from 424 m. Under operating Regime 2, a major draw down may be limited to an

estimated once in every 35 years. Under both regimes daily fluctuations would be up to 2 m in March and April and 1.5 m during the balance of the year.

5.3 Potential Impacts to Wildlife

5.3.1 Ungulates

Impacts from the Murphy Creek Project, though most tend to be negative, are expected to be only minor or insignificant to ungulate populations and habitats. One exception is the loss of some winter range, which has been assessed as a moderate negative impact. The potential impacts are discussed in the following section in terms of the specific environmental changes which are expected to occur, and are summarized in Table 11.

1. Water Level

The areas of wildlife habitat which may be flooded are restricted to lower Pass Creek and Champion Creek. The remainder of the flooded area is confined primarily to steep terrace slopes which have little value as wildlife habitat, or to areas which have already been alienated by residential, linear, industrial or agricultural development. The lowest terrace in the study area is at 460 meters. Proposed normal reservoir operating level is at 424 m, therefore most of the flooded area would encompass the steep slope to the river on which there is little vegetation. Some valley bottom wintering habitat would be lost. This removal of winter habitat would be a direct long-term effect, but because of the small amount of land involved, represents only a moderate impact for local deer populations.

From our data and comparisons with land capability ratings identified by Blower (1973) and Demarchi et al. (1982) the following densities of deer could be expected in the habitat types identified earlier: moderate/high - up to 23 per sq. km; low/moderate - up to 15 per sq. km; very low - up to 8 per sq. km. Areas have been calculated (Table 12) which identify the amount of deer habitat eliminated at full pool elevations of 424 m, 427 m and 430 m for

TABLE 11: Summary of Project Characteristics and Their Related Impacts

	Construction		Reservoir Filling & Operation			
	Dam Site & Reservoir Preparation	Till Site*	Water Level	Wind	Access	Reservoir Fluctuations
Deer						
Numbers	-1	-1	-2	-1	-2	-1
Distribution	-1	-1	-2	-1	-1	-2
Habitat - Winter	-1	-2	-3	-1	0	-1
Habitat - Summer	-1	-2	-2	0	0	-1
Movements	-2	-1	-2	-1	-2	-2
Non-Consumptive Use	-1	-1	-1	0	+2	0
Consumptive Use	-1	-1	-1	0	+2	0
Aquatic Furbearers	-1	0	+1	-1	0	-2
Terrestrial Furbearers	-1	-1	-2	0	0	-1
Aquatic Birds						
Ducks	-1	0	-2	-1	0	-2
Mergansers	-1	0	-3	-1	0	-2
Consumptive Use	-1	0	-2	0	+1	0
Terrestrial Birds						
Upland Game	-1	-1	-2	-1	-1	0
Raptors	-2	0	-2	+1	0	0
Consumptive Use	-1	-1	-1	0	+1	0

0 - no effect
1 - insignificant
2 - minor
3 - moderate
4 - major

* A revegetation program is assumed in this assessment.

comparison. So as not to confuse areas estimated here with those estimated for property impact considerations (B.C. Hydro, 1983), areas above and below mean annual high water (the lower level employed for property impacts) have been differentiated. Effective deer habitat extends an estimated 115.1 ha below this. The areas to be flooded have been assessed in terms of the carrying capacities identified for various habitat classes (Blower, 1973; Demarchi et al., 1982; Appendix 3-4) and the resulting loss of carrying capacity has been calculated (Table 13). The potential habitat loss at the 424, 427 and 430 m elevations could eliminate the carrying capacity for 5, 7 and 9 deer or 18, 26 and 32 deer respectively, depending on the habitat capability scheme used. As indicated in Section 4.1.3 the carrying capacity estimates differ according to author. Their use in this report is merely to provide a guide to the magnitude of habitat loss.

TABLE 12: Estimated Flooding of Deer Winter Habitat at Selected Full Pool Elevations (in hectares)

Habitat Rating	424 m	427 m	430 m
Above Mean Annual High Water			
Altered	4.9	30.1	43.3
Low	247.3	372.6	456.6
Low-Moderate	25.8	43.3	50.9
Moderate-High	6.1	12.1	21.1
Subtotal	284.1	458.1	571.9
Below Mean Annual High Water			
Altered	1.2	1.2	1.2
Low	100.9	100.9	100.9
Low-Moderate	11.0	11.0	11.0
Moderate-High	2.0	2.0	2.0
Subtotal	115.1	115.1	115.1

* Areas in hectares

TABLE 13: Carrying Capacity of Potentially Lost Habitat According to Selected Full Pool Elevations

	River to 424 m		River to 427 m		River to 430 m	
	1*	2*	1	2	1	2
Moderate to High	2	F1	3	1	4	2
Low to Moderate	4	1	6	2	7	2
Very Low	12	3	17	4	21	5
Total	18	5	26	7	32	9

* 1 = Blower, 1973; 2 = Demarchi et al.(1982)

Elk are found at the north end of the study area, and are concentrated largely above the 500 m elevation. Flooding at the north end of the study area would involve minimal amounts of elk habitat. As a consequence, no adverse impacts owing to project development are anticipated for the elk population of the study area.

2. Water Level Fluctuations

Annual fluctuations are a component of operating Regime 1 (B.C. Hydro, 1982). Operating Regime 2 differs by not requiring annual draw down. Daily fluctuations are not likely to have impacts on wildlife.

3. Climatic Change

B.C. Hydro (1981b) has predicted an increase in wind speeds within the study area. The probability and severity of increased winter winds would likely be an insignificant negative impact upon wildlife in the area.

The overall effect of the dam on the temperature and precipitation of the area is expected to be negligible (B.C. Hydro, 1981b) and would therefore have no effect on wildlife or their habitat.

4. Construction

Construction activities would result in a direct temporary disruption of wildlife use in the spoil and work areas near the dam. Habitat capability in the vicinity of the proposed dam is not high, thus, impacts on wildlife though negative would be insignificant. Further construction impacts are not expected.

5. Access

Improved access would only be provided to the east side of the river by the construction of the Murphy Creek dam for construction purposes. Subsequently, B.C. Hydro does not plan to provide vehicle access across the dam.

6. Till Site

Removal of till from the Murphy Creek site would involve minor impacts on wildlife (Table 11). The duration of these impacts can be reduced from long-term to short-term by the implementation of appropriate reclamation practices to re-establish suitable vegetation cover.

Since the borrow pit would only be used for 2 summer months during the year (year 4) of the construction activity, it is expected that impacts can be kept to a minimum. The operation would not disrupt wintering animals and is restricted to an estimated 13.2 ha.

Trucks hauling till during these 2 months are not likely to endanger many animals because deer use higher elevations during the summer.

7. Relocation of Railway

The existing railbed extending along the western side of the river, passes through wildlife habitat that is considered low capability. The adjustment of

the railbed upslope is required because the present alignment would be below minimum freeboard once the dam is at full pool.

The relocation of the railway would remain in what is considered low capability habitat. The low elevation slopes along the west side of the river receive little use by deer. In this area in particular, winter use seems to be confined to terraces and south slopes above the 500 m contour. The low elevations tend to be steep and because of other disturbances such as housing, highway and the present railroad, receive little use by ungulates.

In addition to the relocation of the railroad, some slope protection measures would be taken at various points within the study area. All of these areas are also within low capability or altered type habitat. So for all of these adjustments minimal negative impacts on wildlife are evident.

8. Potential Indirect impact

One possible indirect impact may be the extra costs incurred by resource agencies for management programs necessitated by increased human population. Because of the various hydroelectric projects that have taken place in the area in recent years, the local labor force would probably supply the majority of skilled workers for the Murphy Creek project. An estimated influx of less than 500 out-of-region workers are expected (DPA, 1983) at the peak, so secondary costs to resource agencies should be minimal.

5.3.2 Furbearers

Terrestrial furbearers no doubt occur below the 500 m contour. Other than bear, these would include red squirrel, weasel, skunk, racoon coyote and red fox. Bobcat, lynx and marten may be found occasionally. Because virtually no trapping for terrestrial furbearers occurs in the study area, and track counts could not be conducted in the absence of snow, no quantified impacts can be provided.

Aquatic furbearers in the study area are trapped regularly, even at a low level of effort. According to discussions with trappers, this low effort reflects the generally poor aquatic furbearer habitat of the study area and the apparently low numbers. The impact of the project is judged to have a minor negative impact, with the main contributing negative influence being the reservoir fluctuations. Based on reported trapping success in the reservoir above the Brilliant dam, a relatively stable reservoir might have improved aquatic furbearer habitat.

5.3.3 Birds

Aquatic Birds

Conducting surveys of aquatic birds in the adjacent reservoirs above the Brilliant and Hugh Keenleyside Dams was the chief strategy employed in determining impacts. The birds of these reservoirs (one stable, the other regulated) offer some insight into the future aquatic bird community of the proposed reservoir. The impact assessment is summarized in Table 11, but the chief attributes of the project which would influence aquatic birds would be increased water levels and reservoir fluctuations. The other sources of impact would appear to be negligible in comparison.

Divers: Divers occur in the study area in such small numbers that impacts cannot be meaningfully addressed.

Geese: Only Canada geese occur in the study area in sufficient numbers to warrant consideration. Few Canada geese were observed in the study area, and the only nearby resident population is located in the Brilliant Dam reservoir. Fluctuations in this reservoir are minor, and at no time is there a major late winter - early spring draw down as occurs in the Arrow Lakes Reservoir and is planned for the Murphy Creek Project under operating Regime 1. As a consequence, marsh development has occurred along the margins of the Brilliant reservoir and benefitted by a gently sloping topography, pastureland occurs to the water's edge in many places. This provides relatively good habitat for geese. The Murphy Creek Project is not likely to have any measurable negative impacts on the small number

of geese occasionally found in the study area, but operating Regime 1 fluctuations in the reservoir would likely prevent any habitat improvement around the reservoir perimeter. Operating Regime 2, whose fluctuations are largely daily, might accomodate some marsh development.

Dabbling Ducks: The considerations that apply to Canada geese apply to the dabbling ducks, except that dabbling ducks utilize the study area in much greater numbers. Mallards breed in the proposed reservoir area. An annual draw down would make the proposed reservoir area less attractive to birds. The timing of the draw down, overlapping most of the spring migration (late March to late May), would magnify this tendency, and discourage possible breeding. Marsh habitats which might have developed in certain gentle sloping areas would not occur. Operating Regime 2 would appear to obviate some of these constraints.

Because a large portion of the dabbling ducks occur on the Columbia River above the confluence with the Kootenay River, where flooding and reservoir fluctuations would be minor, some dabbling duck utilization of this area would continue. Impacts would be moderate, long-term and negative. The numbers impacted would be considered small in a regional context both from the perspective of seasonal residents and migrants.

Diving Ducks: In the study area and adjacent reservoirs, diving ducks are primarily migrants and winter residents, occurring from late October to late April. Few appeared to occur on the fluctuating reservoir above the Hugh Keenleyside Dam, and the evaluation of this study is that numbers would decline subsequent to the project. Part of this might be explained by the reservoir fluctuations and by the failure to develop submergent aquatic vegetation and associated fauna. This decline in numbers would be less noticeable at the upper ends of the reservoir, where it would be shallower. The implementation of operating Regime 2 would reduce the level of negative impacts.

In summary, impacts would be minor, long-term and negative, but involve small numbers in a regional context.

Mergansers: Mergansers have been separated from the other diving ducks, because of a distinctive life-history, particularly as a fish-eaters, and in their preference for flowing water. Merganser numbers were much higher in the study area than in the adjacent reservoirs, and subsequent to this project a 60-75% reduction in numbers is likely. This constitutes a moderate long-term, negative impact to a population whose numbers in a regional context are proportionately much greater than dabbling and diving ducks.

Shorebirds: Though killdeers were observed during the aerial surveys, it is the spotted sandpiper which is common along the banks of the Columbia River. Numbers were much lower around the adjacent reservoirs. They appear to prefer the rocky shorelines of rivers and creeks, and the flooding of the reservoir would eliminate this habitat. The further fluctuation of this reservoir would likely prevent any re-establishment of suitable replacement habitat. This impact is considered moderate and long-term in a local context. Johnsgard (1981) considers this is probably the most abundant scolopacid sandpiper in North America, therefore, in a broader context, impacts are much less significant.

Terrestrial Birds

Raptors: Osprey nest in the study area and along the adjacent reservoirs. The Murphy Creek Project would eliminate one nest site and endanger one other. The old telephone lines which cross the Columbia River above its confluence with the Kootenay River would be relocated. One traditional osprey nest-site is located on the wires and would be lost when they are relocated. The other site, the top of one of the dolphins adjacent to the BC Timber Ltd. mill, the 2-3 m water level rise would reduce the distance between the nest (estimated at 7 m above the river at present) and log sorting immediately below. This may increase disturbance and cause nest site abandonment. Alternate nest sites may be available, but artificial ones may have to be considered. This impact is judged to be minor.

Bald eagles occur in the study area in winter in small numbers. The chief impact, if any, would relate to forage, and this is considered an insignificant impact.

Any significant clearing of cottonwoods might have a temporary minor negative impact on the cavity nesting species such as Kestrels.

Upland Game: This category refers primarily to ruffed grouse. Some habitat in the Champion Creek area and the Genelle to Blueberry area would be lost, but surveys conducted for this study and local contacts indicate that the main ruffed grouse concentration centers occur above the reservoir area. As a consequence, impacts, though negative and long-term, would be minor.

6.0 MITIGATION MEASURES

Although impacts predicted for the wildlife resources of the study area due to project development are mostly minor or less, there is some potential to implement a number of mitigation measures. These would ameliorate or compensate for any impacts which may arise.

1. Reservoir Filling

Small amounts of ungulate winter range may be lost, and some consideration should be given to cost efficiency of compensating for this loss by the manipulation of remaining winter range to improve its carrying capacity. This may be accomplished by increasing the amount of cover, increasing the abundance and availability of browse species, or by a combination thereof.

Vold et al. (1980) described some possible management strategies for improving winter range conditions specifically for white-tailed deer, but they may include benefits for all deer residing in the Columbia Valley. These include the manipulation of vegetation by logging and prescribed burning, or the more intensive strategies such as fertilization, seeding or shrub cutting.

The upper terraces along Murphy Creek have been identified as one of the more important wintering areas in the valley. Management techniques that could improve this and adjoining areas could be applied. Another potential area for improvement would be the terraces of Champion Creek.

The possible management options available should be discussed with resource managers in the area and strategies for improvement of winter ranges adjacent to inundated areas undertaken.

Although waterfowl impacts were considered to be minor, enhancement was considered. However, morainal deposits in the Castlegar area prevent any wetland creation of significance under Regime 2 (I. McIntosh, B.C. Hydro, pers. comm.). Initial reservoir flooding should take place after July to avoid

inundating the breeding efforts of birds and prior to mid-October to avoid inundating hibernating or aestivating mammals.

2. Water Level Fluctuations

Under Regime 2, these should not be a major issue in terms of wildlife utilization.

3. Climatic Changes

The climatic changes in the area are expected to be negligible.

4. Construction

Construction activities should be confined to as small an area as possible. Construction activities should also take place during summer months when deer are not on winter ranges and are more evenly dispersed.

All work and spoil areas disturbed by construction should be reclaimed in order to minimize erosion and to possibly provide additional forage for ungulates.

One construction impact would be the loss of one osprey nest site. Artificial nest sites for ospreys have been established at the wildlife refuge near Creston. With recent modifications these have proved to be successful (Robert Butler, Canadian Wildlife Service pers. comm.). To compensate for the one site and the possible loss of the second, the response of the ospreys should be monitored and if required two artificial structures should be established.

5. Access

To minimize increased pressure on deer both from hunting and harassment, all access roads should be strictly controlled during the construction period. Following construction access roads should be permanently closed.

6. Till Sites

The Murphy Creek till site should remain as small in area as possible. The restriction of its use to 2 months during a summer would minimize impacts. Because trucks would also be hauling only in summer, this would minimize possibilities of deer mortality as a result of collisions.

Till sites should be reclaimed immediately following use.

7. Railway Relocation

Because the relocated line would be in habitat which is considered low value, impact is considered minimal. Those areas that are disturbed should be reseeded to prevent erosion. Most of these slopes are quite steep.

8. Indirect Wildlife Management Costs

The proposed increase of workforces from out of the region would not appear to cause significant increase in management costs.

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APPENDIX I
TERMS OF REFERENCE

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

TERMS OF REFERENCE
FOR
ENVIRONMENTAL STUDIES
FOR THE
PROPOSED MURPHY CREEK
HYDROELECTRIC PROJECT

Draft No. 2

February 1980

SYSTEM ENGINEERING DIVISION

TERMS OF REFERENCE

FOR ENVIRONMENTAL STUDIES FOR THE PROPOSED

MURPHY CREEK HYDROELECTRIC PROJECT

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1.0 INTRODUCTION

These Terms of Reference are for detailed ecological and socio-economic studies, called the "Studies", which are required for environmental impact evaluation of a potential hydroelectric development by the British Columbia Hydro Electric and Power Authority (B.C. Hydro) on the Columbia River in the vicinity of Murphy Creek.

Prior to signing the Columbia River Treaty in 1961 and its ratification in 1964, numerous studies were made of the hydroelectric development of the Columbia River in Canada. The Treaty between the United States and Canada led to the construction of Mica, Hugh Keenleyside and Duncan projects in Canada. Other major hydroelectric projects in the Columbia River basin in Canada include the Kootenay Canal project completed in 1975, and the Seven Mile and Revelstoke projects which are under construction.

The potential of the Murphy Creek site was first identified in 1956. Consideration of the development of the project was more recently given during the 1972 B.C. Energy Board studies. Subsequently, preliminary engineering and environmental studies were carried out in 1977 and 1978, to examine the project potential at a prefeasibility level and to identify probable environmental impacts.

The Murphy Creek site is located on the Columbia River approximately 3 km upstream of the city of Trail and 25 km downstream of the confluence of the Columbia and Kootenay rivers. The tentative layout for the project consists of an earthfill dam, approximately 33 m high, extending across the river from the left bank to a concrete spillway and 10-unit powerhouse located on the right bank. A total installed capacity of 400 MW would be provided by ten 40 MW turbine generators.

In early 1979 a preliminary study of the residential, commercial and industrial properties that may be affected by the

1.0 INTRODUCTION - (Cont'd)

project was undertaken by the Properties Division. An engineering feasibility study scheduled for completion by the end of 1980 is in progress.

All field work associated with the Studies outlined in these Terms of Reference is scheduled for completion in 1980 where possible, in order that environmental impacts may be properly assessed by mid-1981. The engineering feasibility study associated with the project is being carried out by the Hydroelectric Generation Projects Division of B.C. Hydro, who will also be responsible for several aspects of the Studies such as geology, hydrology and river morphology.

2.0 STUDIES AREA

The Studies area consists of all lands on either side of the Columbia River from the axis of the proposed dam in the vicinity of Oasis, upstream to the Hugh Keenlyside dam on the Columbia River, and to the Brilliant dam on the Kootenay River, up to an elevation of 500 m. Studies may extend beyond this area in specific cases where considered necessary.

Some areas outside these limits will be studied for socio-economic impacts from both the construction work force and the operating staff.

3.0 STUDIES OBJECTIVES

1. To provide an inventory of environmental resources that could be impacted by the potential project within the Studies area. This will be compiled from on-site investigations and other available sources.

2. To provide a qualitative and quantitative evaluation of impacts, both adverse and beneficial, which would result from the potential project.

3.0 STUDIES OBJECTIVES - (Cont'd)

3. To provide an evaluation of resource losses and gains in monetary terms for inclusion in a benefit-cost analysis.

4. To provide data which could be needed for preparation of an Environmental Impact Statement for the potential project.

4.0 STUDIES ORGANIZATION

(a) Co-ordination

The entire program will be directed and co-ordinated either by B.C. Hydro, or by B.C. Hydro assisted by a prime consultant. Under this direction, certain disciplines of the Studies will be carried out by B.C. Hydro staff or by consultants. Technical responsibility within individual disciplines will rest with the B.C. Hydro staff or with respective consultants. B.C. Hydro or its prime consultant will assume the role of co-ordinating the individual disciplines during the Studies period and during the preparation of the final report.

Consultants should liaise with the appropriate government agencies both before and during their studies to ensure that full use is made of existing available information and knowledge.

Consultants, subconsultants and their staff shall co-operate with all other consultants hired by B.C. Hydro for the same or similar projects, and on request by B.C. Hydro shall make available to such consultants all material gathered or produced for this project.

All contact with outside agencies and the public shall be co-ordinated through B.C. Hydro.

4.0 STUDIES ORGANIZATION - (Cont'd)

(b) Studies Sections

The Studies shall be organized into four groups: Physical Resources, Terrestrial Resources, Aquatic Resources and Socio-economic. Each group is composed of closely related subjects called "Sections" A to L, as follows:

Physical Resources

A Geology and Landforms
B Hydrology and River Morphology
C Water Quality
D Climate

Terrestrial Resources

E Agriculture
F Vegetation
G Forestry
H Wildlife

Aquatic Resources

I Fish and Aquatic Habitats

Socio-economic

J Regional Economy and Human Communities
K Recreation and Tourism
L Heritage Resources
M Resource Analysis

5.0 STUDIES METHODOLOGY

Evaluation of the environmental impact of the project shall take into consideration all project actions associated with the development. These shall include pre-project activities such as field

5.0 STUDIES METHODOLOGY - (Cont'd)

investigation or land acquisition; construction activities such as site and reservoir clearing, dam, powerhouse and road construction, construction camp activities; and operation and maintenance of the powerplant. Project descriptions will be provided by B.C. Hydro.

Definition and development of all methodologies for the Studies should be made early in the program and provided to B.C. Hydro for their approval. This may include the use of various impact matrices, mapping techniques, economic analyses, etc. The methodology for evaluation in each of the Sections shall be consistent with criteria selected for the evaluation of the environmental impact. Special attention shall be directed to providing information suitable for inclusion in a benefit-cost analysis of mitigation and compensation alternatives.

The following is provided by B.C. Hydro to give direction on the scope of the Studies:

1. All resources and their significance, with and without the project, on a local, regional and provincial scale based upon present value and potential value.

2. Environmental impacts including:

   a. Primary, secondary and induced impacts.

   b. Beneficial and adverse effects.

3. Distributional aspects of impacts including:

   a. Geographical - local, regional, provincial and international.

   b. Social - impacts on various segments of the population, ethnic or special interest groups.

5.0 STUDIES METHODOLOGY - (Cont'd)

c. Transfer of resource demands to other locations.

4. Probability of occurrence of an impact and reasons for uncertainty of the impact's occurrence.

5. Expected time and duration of an impact occurrence. A distinction shall be made between short-term impacts (those which last for the construction period only) and long-term impacts (those which persist after construction).

6. Possible benefits, both short and long-term, of all compensation and mitigation measures.

7. The costs associated with all compensation and mitigation measures.

8. Relationship between project impacts and long-term regional development prospects shall be evaluated.

All sources of data, information and references shall be thoroughly documented.

6.0 REPORTING PROCEDURES

Written reports will be required for all Sections of the Studies. The number of copies of such reports will be established at the time study proposals are called for. Prior to the preparation of these reports, consultants will be required to submit a report outline to B.C. Hydro for review and approval. Subsequently, draft reports will be prepared and submitted for review and approval by B.C. Hydro and, where necessary, by outside experts before they are accepted. All final reports shall be in a form suitable for release to government agencies and the public.

6.0 REPORTING PROCEDURES - (Cont'd)

Following completion of all the reports for the Sections, B.C. Hydro or its prime consultant will prepare an integrated summary report in consultation with the authors of the Sections and outside experts, where necessary. This report will be the final report of the Studies.

7.0 STUDIES SCHEDULE

The Studies will be undertaken in 1980 and possibly beyond. A target schedule showing specific deadlines will be issued for each Section.

8.0 STUDIES SECTIONS

The following are guidelines for each of the Sections. These guidelines distinguish between inventory and assessment work and, where feasible, this distinction should be made in report preparation.

SECTION H

WILDLIFE

Wildlife studies should be directed towards the habitats available within the flooded area, and their use by the important wildlife species. This consultant should work closely with the consultant preparing the Vegetation Inventory Report to ensure it is prepared in a manner which best describes and outlines the various wildlife habitats. Any rare or endangered mammals, birds, reptiles or amphibians should be discussed.

H.1 UNGULATES

(a) Inventory

Determine ungulate abundance, distribution and migration patterns in all seasons of the year. Relate ungulate densities and distribution to the available habitat types.

Quantitatively determine the use of each habitat type by the various ungulate species present.

Identify and map areas of special importance to specific species i.e. mineral licks, winter concentration areas.

Identify current and potential use of ungulates in relation to consumptive and non-consumptive activities.

(b) Effect of Development

Identify impacts and predict quantitatively the changes which might ensue from project actions on the various ungulate populations in the vicinity of the areas affected by the project.

H.1 UNGULATES - (Cont'd)

Make recommendations on mitigatory actions which might be taken in the case of an adverse impact, or compensatory programs which might be practically developed.

H.2 FURBEARERS

(a) Inventory

Assess the relative abundance and distribution by habitat of small fur bearing mammals.

Collect fur harvest data for registered traplines.

Identify current and potential use of furbearers in relation to consumptive and non-consumptive activities.

(b) Effect of Development

Identify impacts and predict quantitatively the changes which might ensue from project actions on the various fur bearing species in the vicinity of the areas affected by the project.

Make recommendations on mitigatory actions which might be taken in the case of an adverse impact, or compensatory programs which might be practically developed.

H.3 WATERFOWL AND OTHER BIRDS

Determine the distribution and numbers of waterfowl by species in relation to nesting, feeding and staging. Provide an inventory of all suitable and potential waterfowl habitat. Determine the chronology of spring and fall migrations through the study area. Provide estimates of numbers and species of birds involved, and their probable migration corridors.

H.3 WATERFOWL AND OTHER BIRDS - (Cont'd)

Provide indices of habitat use by various species of birds, with special reference to upland game birds. Indicate relative degrees of use for feeding, cover, nesting, etc.

Summarize all available information on hunter use of waterfowl and upland game bird populations within the study area.

Effect of Development

Predict potential changes in waterfowl occurrence, distribution and number occurring as a result of reservoir formation. Distinguish between any losses of natural habitats and provision of new aquatic habitats by reservoir formation.

Predict impacts of flooding on upland game bird habitats and populations.

Note any potential changes to hunter use of waterfowl and upland game birds.

Make recommendations on mitigatory actions which might be taken in the case of an adverse impact, or compensatory programs which might be practically developed.

APPENDIX 2

SCIENTIFIC AND COMMON NAMES

APPENDIX 2-1: Scientific[1] and Common Names of Plants Referred to in Text

Species	Common Name
POLYPODIACEA	
Pteridium aquilinum (L.) Kuhn	bracken fern
TAXACEA	
Taxus brevifolia Nutt.	pacific yew
CUPRESSACEAE	
Juniperus scopulorum Sarg.	western juniper
Thuja plicata Donn.	red cedar
PINACEA	
Abis grandis (Dougl.) Forbes	grand fir
Larix occidentalis Nutt.	western larch
Picea engelmannii Parry	Engelmann spruce
Picea glauca (Moench) Voss	white spruce
Pinus contorta var. *latifolia* Engelm.	lodgepole pine
Pinus monticola Dougl.	western white pine
Pinus ponderosa Dougl.	ponderosa pine
Pseudotsuga menziesii (Raf.) Sarg.	western hemlock
SALICACEA	
Populus tremuloides Michx.	trembling aspen
Populus trichocarpa T. & G.	black cottonwood
Salix spp.	willow
BETULACEAE	
Alnus incana (L.) Moench	mountain alder
Betula papyrifera Marsh.	white birch
Corylus corunata Marsh.	hazelnut
BERBERIDACEAE	
Berberis nervosa Pursh.	Oregon grape
ROSACEAE	
Amelanchier alnifolia Nutt.	Saskatoon
Physocarpus malvaceus (Greene) Kuntze	ninebark
Prunus virginiana L.	chokecherry
Pyrus malus L.	apple
Rosa woodsii Lindl.	rose
Rubus idaeus L.	raspberry

APPENDIX 2.1 Cont'd: Scientific[1] and Common Names of Plants Referred to in Text

Species	Common Name
CELASTRACEAE	
Pachistima myrsinites (Pursh) Raf.	boxwood
ACERACEA	
Acer glabrum var. *douglasii* (Hook.) Dippel	Douglas maple
RHAMNACEA	
Ceanothus sanguineus Pursh	red-stem ceanothus
Ceanothus velutinus Dougl.	snowbrush
ERICACEAE	
Arctostaphylos uva-ursi (L.) Spreng.	bearberry
Chimaphila umbellata (L.) Bart.	prince's pine
Vaccinium membranaceum Dougl.	
CAPRIFOLIACEAE	
Linnea borealis L.	twinflower
Sambucus cerulea Raf.	blue elderberry
Symphoricarpus albus (L.) Blake	snowberry
LILIACEAE	
Clintonia uniflora (Schult.) Knuth	queen's cup
Smilacina racemosa (L.) Desf.	false Solomon's seal

1 Nomenclature according to Hitchock & Cronquist (1973).

APPENDIX 2-2: Common and Scientific[1] Names of Furbearers Harvested in the Vicinity of the Proposed Murphy Creek Development

Common Name	Scientific Name
American Beaver	*Castor canadensis*
Bobcat	*Lynx rufus*
Coyote	*Canis latrans*
Lynx	*Lynx lynx*
Marten	*Martes americana*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Otter	*Lontra canadensis*
Raccoon	*Procyon lotor*
Red Squirrel	*Tamiasciurus hudsonicus*
Weasel (ermine)	*Mustela erminea*
Red Fox	*Vulpes vulpes*
Skunk	*Mephitis mephitis*

[1] Nomenclature from Banfield, 1974.

APPENDIX 2-3: Common and Scientific Names of Birds Referred to in Text

Common Name	Species
Common Loon	*Gavia immer*
Arctic Loon	*Gavia arctica*
Red-necked Grebe	*Podiceps griseagena*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps caspicus*
Western Grebe	*Aechmorphorus occidentalis*
Pied-billed Grebe	*Podilymbus podiceps*
Great Blue Heron	*Ardea herodias*
Whistling Swan	*Olor columbianus*
Trumpeter Swan	*Olor buccinator*
Canada Goose	*Branta canadensis*
White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen hyperborea*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
European Widgeon	*Anas penelope*
American Widgeon	*Anas americana*
Northern Shoveler	*Anas clypeata*
Wood Duck	*Aix sponsa*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Barrow's Goldeneye	*Bucephala islandica*
Bufflehead	*Bucephala albeola*
Oldsquaw	*Clangula hyemalis*
Harlequin Duck	*Histrionicus histrionicus*
White-winged Scoter	*Melanitta deglandi*
Surf Scoter	*Melanitta perspicillata*
Ruddy Duck	*Oxyura jamaicensis*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Red-breasted Merganser	*Mergus serrator*
Bald Eagle	*Haliaeetus leucocephalus*
Osprey	*Pandion haliaetus*
American Kestrel	*Falco sparverius*

APPENDIX 2-3 Cont'd: Common and Scientific Names of Birds Referred to in Text

Common Name	Species
Blue Grouse	*Dendragapus obscurus*
Franklin's (Spruce) Grouse	*Canachites canadensis*
Ruffed Grouse	*Bonasa umbellus*
American Coot	*Fulica americana*
Killdeer	*Charadrius vociferus*
Common Snipe	*Capella gallinago*
Spotted Sandpiper	*Actitis macularia*
Herring Gull	*Larus argentatus*
California Gull	*Larus californicus*
Ring-billed Gull	*Larus delawarensis*
Bonaparte's Gull	*Larus philadelphia*
Common Tern	*Sterna hirundo*
Black Tern	*Chlidonias niger*
Belted Kingfisher	*Megaceryle alcyon*
Dipper	*Cinclus mexicanus*

APPENDIX 3

WILDLIFE DATA

APPENDIX 3-1: Highway Mortalities of Wildlife for the Trail/Castlegar Area as Provided by the B.C. Fish & Wildlife Branch for the Period 1978 to 1981

Year	ZONE			SEASON			
	North West	Middle West	South West	Winter (Jan-Mar)	Spring (Apr-Jun)	Summer (Jul-Sep)	Fall (Oct-Dec)
1978	1 WT	10 WT	3 WT	14 WT 1 CT	0	0	0
1979	1 BB	1 BB 1 MD 1 WT	1 WT	0	0	2 WT 1 MD 1 BB	1 BB
1980	3 WT	13 WT	3 WT	9 WT	4 WT	6 WT	0
1981	0	5 WT	0	5 WT*	0	0	0

* To 30 March 1981

Legend

WT - Whitetailed Deer
CT - Coyote
BB - Black Bear
MD - Mule Deer

APPENDIX 3-2: Wildlife Sightings in the Study Area as Provided by Members of the Trail Wildlife Association, 1968 to 1981

	ZONE						SEASON			
Source/Year	North West	Middle West	South West	North East	Middle East	South East	Winter (Jan-Mar)	Spring Apr-Jun)	Summer (Jul-Sep)	Fall (Oct-Dec)
Carlo Degan (Genelle)										
1968				12 WT	77 WT		89 WT			
Peter Stent										
1978		3 WT								3 WT
1979		1 WT 4 MD					1 WT 4 MD			
1980		8 MD			28 WT	4 MD	8 MD 28 WT	4 MD		
1981	6 WT						6 WT			
Ron & Gord Mailey (Trail)										
1980			5 WT			7 WT 3 MD			5 WT	7 WT 3 MD
1981						4 MD	4 MD			
Rob Frew, Ken Mailey, Gary Nutini, Danny Aberante (Trail)										
1980		88 WT 86 MD			72 WT		88 WT 86 MD			72 WT
1981		61 WT			15 WT		76 WT			

APPENDIX 3-3: Browse and Pellet Group Survey Results

Transect	Pass Creek													
Plot Number	1	2	3	4	5	6	7	8	9	10	11	12	f[2]	B[3]
Cover														
TREES														
Abies grandis	-	-	r	2	-	-	-	-	-	-	-	-	17	
Acer glabrum	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alnum tenuifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	
Betula papyrifera	2	2	2	2	2	2	1	-	-	-	3	+	75	
Crataegus douglasii	-	-	-	-	-	-	-	-	-	-	-	-	-	
Larix occidentalis	-	-	-	-	2	2	1	1	+	+	-	r	58	
Pinus monticola	-	2	-	-	-	-	-	-	-	-	-	-	8	
Pinus ponderosa	-	-	-	-	-	-	-	-	2	1	-	-	17	
Populus tremuloides	-	-	-	-	-	-	-	-	-	-	-	-	-	
Populus trichocarpa	3	-	-	-	-	-	-	-	-	-	-	-	8	
Pseudotsuga menziesii	-	2	3	2	1	-	2	3	1	1	r	-	83	
Pyrus malus	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rhamnus purshiana	-	-	-	-	-	-	-	-	-	-	-	-	-	
Taxus brevifolia	-	r	-	1	-	-	-	-	-	-	-	-	17	
Thuja plicata	-	r	2	2	1	-	2	+	-	-	r	3	67	
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	-	-	3	8	
SHRUBS														
Amelanchier alnifolia	-	-	-	-	-	-	-	-	2	1	-	-	17	H
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ceanothus sanguineus	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ceanothus velutinus	-	-	-	-	-	-	-	-	-	-	-	-	-	
Corylus corunata	-	3	-	-	3	3	-	-	-	-	-	-	25	L
Holodiscus discolor	-	-	2	-	-	-	2	-	-	-	-	-	17	
Linnea borealis	-	-	-	-	-	-	1	-	-	-	-	-	8	
Mahonia aquifolium	-	2	1	-	+	-	+	-	1	2	2	-	58	
Pachistima myrsinites	-	2	1	-	3	5	-	-	-	-	-	+	42	
Philadelphus lewisii	-	-	-	-	-	2	1	2	-	-	-	-	25	
Rosa gymnocarpa	-	-	-	-	-	1	-	2	-	-	-	-	17	L
Rubus parviflorus	-	-	-	-	-	-	-	-	-	-	-	-	-	
Shepherdia canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	
Symphoricarpus albus	-	-	-	-	-	-	-	3	-	-	-	-	-	
Vaccinium membrenaceum	-	-	-	-	-	-	-	-	-	-	-	-	-	
GROUND COVER														
Achillea millefolium	-	-	-	-	-	-	-	-	-	-	-	-	-	
Apocynum androsaemifolium	-	-	-	-	1	-	-	-	-	-	-	-	8	
Campanula rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cirsium vulgare	2	-	-	-	-	-	-	-	-	-	-	-	8	
Clintonia uniflora	-	-	-	+	-	-	-	-	-	-	-	-	8	
Disporum trachycarpum	-	-	-	-	-	-	-	+	-	-	+	-	17	
Pteridium aquilinum	-	-	-	-	-	-	1	+	-	1	+	+	42	
Rumex acetosella	-	-	-	-	-	-	-	-	-	-	-	-	-	
Solanum spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	
Miscellaneous forbs	-	-	-	-	-	-	-	-	+	1	-	-	17	
Grasses	3	2	-	2	1	-	2	-	2	2	-	-	58	L
Mosses	2	-	-	-	-	-	-	-	-	-	-	-	8	
PELLET GROUPS	-	-	-	-	-	-	-	1	2	2	1	0	33	

[1] Braun Blanquet Cover - Abundance Scale

5 >75%
4 50-75%
3 25-50%
2 5-25%
1 <5%
\+ few, small cover
r solitary small cover

[2] f = % Frequency per transect

[3] B - Browse

H Heavy
L Light
M Moderate

APPENDIX 3-3 Cont'd: Browse and Pellet Group Survey Results

Transect	Champion Creek																				
Plot Number Cover	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	f[2]	B[3]
TREES																					
Abies grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acer glabrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alnum tenuifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	5	L
Betula papyrifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Crataegus douglasii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Larix occidentalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pinus monticola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pinus ponderosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Populus tremuloides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Populus trichocarpa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pseudotsuga menziesii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pyrus malus	-	-	-	+	-	-	-	2	-	2	-	-	-	-	+	-	-	-	-	21	L
Rhamnus purshiana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Taxus brevifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Thuja plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SHRUBS																					
Amelanchier alnifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ceanothus sanguineus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	+	16	H
Ceanothus velutinus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Corylus cornuta	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	2	2	16	M
Holodiscus discolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Linnea borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mahonia aquifolium	-	-	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-	1	+	21	
Pachistima myrsinites	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Philadelphus lewisii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rosa gymnocarpa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	5	L
Rubus parviflorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Shepherdia canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Symphoricarpus albus	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	2	1	16	L
Vaccinium membrenaceum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GROUND COVER																					
Achillea millefolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Apocynum androsaemifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Campanula rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cirsium vulgare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Clintonia uniflora	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Disporum trachycarpum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pteridium aquilinum	-	-	-	-	3	2	-	-	2	1	-	-	-	1	1	-	3	3	2	47	
Rumex acetosella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Solanum spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Miscellaneous forbs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Grasses	-	2	5	5	5	3	5	5	4	3	5	5	5	2	5	5	2	-	5	89	M
Mosses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PELLET GROUPS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	1	-	16	

1 Braun Blanquet Cover - Abundance Scale

5 >75%
4 50-75%
3 25-50%
2 5-25%
1 <5%
+ few, small cover
r solitary small cover

2 f = % Frequency per transect

3 B - Browse

H Heavy
L Light
M Moderate

APPENDIX 3-3 Cont'd: Browse and Pellet Group Survey Results

Transect	China Creek															
Plot Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	f[2]	B[3]
Cover																
TREES																
Abies grandis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Acer glabrum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Alnum tenuifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Betula papyrifera	-	-	-	-	-	1	-	-	+	-	1	1	2	3	43	
Crataegus douglasii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Larix occidentalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pinus monticola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pinus ponderosa	-	-	1	-	-	-	-	-	-	-	-	-	-	-	7	
Populus tremuloides	-	-	-	-	-	2	2	+	-	-	1	1	-	-	36	
Populus trichocarpa	-	-	1	-	-	-	-	-	-	-	-	-	-	-	7	
Pseudotsuga menziesii	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7	
Pyrus malus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rhamnus purshiana	-	-	-	-	-	-	-	-	+	-	-	-	-	-	7	
Taxus brevifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Thuja plicata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SHRUBS																
Amelanchier alnifolia	-	-	-	-	-	-	+	+	-	-	+	-	-	-	21	M
Arctostaphylos uva-ursi	-	-	1	-	-	-	-	-	-	-	-	-	-	-	7	
Ceanothus sanguineus	-	-	-	-	-	-	-	2	-	-	-	-	-	-	7	H
Ceanothus velutinus	-	-	-	5	2	-	+	-	3	3	1	-	2	-	50	L
Corylus cornuta	-	-	-	-	-	2	-	-	-	-	+	1	2	+	36	L
Holodiscus discolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Linnea borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Mahonia aquifolium	-	-	1	-	2	-	3	1	+	-	1	2	1	1	64	
Pachistima myrsinites	-	-	-	-	+	1	3	1	+	-	2	-	2	1	57	
Philadelphus lewisii	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rosa gymnocarpa	-	-	-	-	-	-	-	-	i	1	-	-	+	-	21	L
Rubus parviflorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Shepherdia canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Symphoricarpus albus	-	-	-	1	3	-	-	-	+	-	1	-	-	-	28	L
Vaccinium membrenaceum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GROUND COVER																
Achillea millefolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Apocynum androsaemifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Campanula rotundifolia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Cirsium vulgare	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Clintonia uniflora	-	-	-	+	-	-	-	-	-	-	-	+	-	-	7	
Disporum trachycarpum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pteridium aquilinum	-	-	2	-	-	4	+	+	2	1	1	3	2	2	71	
Rumex acetosella	-	-	+	-	-	-	-	-	-	-	-	-	-	-	7	
Solanum spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Miscellaneous forbs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Grasses	-	-	1	1	+	-	+	2	2	2	-	2	1	1	71	L
Mosses	-	2	-	-	-	-	-	-	-	-	-	-	-	-	7	
PELLET GROUPS	-	-	1	-	-	-	-	3	1	1	1	-	-	-	36	

1 Braun Blanquet Cover - Abundance Scale

- 5 >75%
- 4 50-75%
- 3 25-50%
- 2 5-25%
- 1 <5%
- + few, small cover
- r solitary small cover

2 f = % Frequency per transect

3 B - Browse

- H Heavy
- L Light
- M Moderate

APPENDIX 3-3 Cont'd: Browse and Pellet Group Survey Results

Transect	Murphy Creek												Billy Creek								
Plot Number	1	2	3	4	5	6	7	8	9	10	f[2]	B[3]	1	2	3	4	5	6	7	f[2]	B[3]
TREES																					
Abies grandis	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Acer glabrum	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Alnum tenuifolia	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Betula papyrifera	-	-	-	-	-	1	-	-	-	2	20		-	1	2	2	-	2	+	71	L
Crataegus douglasii	-	2	-	-	-	-	-	-	-	-	10		-	-	-	-	-	-	-	-	
Larix occidentalis	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	2	-	14	
Pinus monticola	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Pinus ponderosa	-	-	-	-	-	-	-	-	-	-	-		-	1	+	+	-	-	-	43	
Populus tremuloides	-	-	-	-	-	-	-	-	-	-	10		-	1	1	+	2	+	+	86	
Populus trichocarpa	-	1	-	-	-	-	-	-	-	-	10		-	-	+	-	-	-	-	14	
Pseudotsuga menziesii	-	-	-	-	-	-	-	-	-	-	-		-	1	-	+	-	-	-	28	
Pyrus malus	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Rhamnus purshiana	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Taxus brevifolia	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Thuja plicata	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Tsuga heterophylla	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	+	-	14	
SHRUBS																					
Amelanchier alnifolia	-	-	-	-	+	-	-	-	-	-	10	L	-	-	-	-	-	-	-	-	
Arctostaphylos uva-ursi	-	-	-	-	-	2	-	-	-	-	10		-	-	-	-	-	-	-	-	
Ceanothus sanguineus	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Ceanothus velutinus	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Corylus cornuta	-	-	-	3	-	-	2	3	-	-	30		-	-	-	-	-	-	+	14	L
Holodiscus discolor	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	14	
Linnea borealis	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Mahonia aquifolium	-	-	+	2	-	+	+	-	1	-	50		-	+	-	-	-	-	2	28	
Pachistima myrsinites	-	-	-	-	2	-	1	-	3	3	40		-	-	-	-	-	-	2	14	
Philadelphus lewisii	-	-	-	2	-	1	-	-	-	-	20		-	-	-	-	-	-	-	-	
Rosa gymnocarpa	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Rubus parviflorus	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Shepherdia canadensis	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Symphoricarpus albus	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	14	
Vaccinium membrenaceum	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
GROUND COVER																					
Achillea millefolium	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Apocynum androsaemifolium	-	-	-	2	-	-	-	-	-	-	10		-	-	-	-	-	-	-	-	
Campanula rotundifolia	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Cirsium vulgare	2	2	-	-	-	-	-	-	-	-	20		-	-	-	-	-	-	-	-	
Clintonia uniflora	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Disporum trachycarpum	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Pteridium aquilinum	-	-	-	-	-	-	-	-	+	-	10		-	2	2	3	2	2	2	86	
Rumex acetosella	-	-	+	-	-	-	-	+	-	1	30		-	-	-	-	-	-	-	-	
Solanum spp.	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Miscellaneous forbs	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
Grasses	2	2	1	2	-	-	-	-	2	2	60	L	-	1	-	+	1	-	3	57	L
Mosses	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	
PELLET GROUPS	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	0	

[1] Braun Blanquet Cover - Abundance Scale

5 >75%
4 50-75%
3 25-50%
2 5-25%
1 <5%
+ few, small cover
r solitary small cover

[2] f = % Frequency per transect

[3] B - Browse

H Heavy
L Light
M Moderate

APPENDIX 3-3 Cont'd: Browse and Pellet Group Survey Results

Transect	Keenlyside									Robson Ridge												
Plot Number	1	2	3	4	5	6	7	f[2]	B[3]	1	2	3	4	5	6	7	8	9	10	f[2]	B[3]
Cover																					
TREES																					
Abies grandis	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Acer glabrum	-	-	-	+	-	-	-	14		-	-	-	-	-	-	-	-	-	-	-	
Alnum tenuifolia	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	2	-	10	
Betula papyrifera	-	-	-	2	-	-	-	14		-	-	-	-	-	-	-	-	2	2	20	
Crataegus douglasii	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Larix occidentalis	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Pinus monticola	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Pinus ponderosa	-	-	-	-	1	2	1	43		-	-	-	-	-	-	-	-	-	-	-	
Populus tremuloides	-	-	-	2	-	-	-	14		-	-	-	-	-	-	-	-	-	-	-	
Populus trichocarpa	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Pseudotsuga menziesii	-	-	-	2	1	-	3	43		-	-	-	-	-	-	-	-	-	2	10	
Pyrus malus	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Rhamnus purshiana	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Taxus brevifolia	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	+	-	10	L
Thuja plicata	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Tsuga heterophylla	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
SHRUBS																					
Amelanchier alnifolia	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Arctostaphylos uva-ursi	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Ceanothus sanguineus	-	-	-	-	-	-	-	-		-	-	-	-	-	2	-	-	-	-	10	L
Ceanothus velutinus	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Corylus cornuta	-	-	-	2	-	-	-	14		-	-	-	-	-	-	-	-	-	1	10	
Holodiscus discolor	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Linnea borealis	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	2	-	10	
Mahonia aquifolium	-	-	-	-	-	-	2	14		-	-	-	-	-	-	3	-	-	-	10	
Pachistima myrsinites	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Philadelphus lewisii	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Rosa gymnocarpa	-	-	-	+	2	-	+	43		-	-	-	-	-	-	-	-	-	-	-	
Rubus parviflorus	-	-	-	-	-	-	-	-		-	-	-	-	-	2	1	-	1	+	40	
Shepherdia canadensis	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Symphoricarpus albus	-	-	-	-	-	+	2	28		-	-	+	-	-	-	-	-	-	-	10	
Vaccinium membrenaceum	-	-	-	-	-	-	+	14		-	-	-	-	-	-	-	-	-	-	-	
GROUND COVER																					
Achillea millefolium	-	-	-	-	-	-	-	-		-	-	-	-	-	-	+	-	-	-	10	
Apocynum androsaemifolium	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Campanula rotundifolia	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Cirsium vulgare	4	4	5	-	2	+	-	71		-	3	3	2	5	-	-	4	-	-	50	
Clintonia uniflora	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Disporum trachycarpum	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Pteridium aquilinum	-	-	2	1	-	-	+	43		-	-	-	-	-	2	2	-	2	2	40	
Rumex acetosella	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	
Solanum spp.	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	+	10	
Miscellaneous forbs	-	-	-	-	-	+	-	14		-	1	-	-	-	-	+	-	-	-	20	
Grasses	2	2	2	-	2	1	2	86		-	4	4	1	2	+	2	2	-	-	70	L
Mosses	-	-	-	-	-	-	-	-		-	-	1	-	4	-	-	1	-	2	40	
PELLET GROUPS	-	-	-	-	-	-	-	0		-	-	-	-	-	-	-	-	1	-	10	

1 Braun Blanquet Cover - Abundance Scale

5 >75%
4 50-75%
3 25-50%
2 5-25%
1 <5%
+ few, small cover
r solitary small cover

2 f = % Frequency per transect

3 B - Browse

H Heavy
L Light
M Moderate

APPENDIX 3-4: Carrying Capacities of Deer Habitat Classes

This Report	Class (Blower, Demarchi et al.)	Densities of Deer/km/year Blower (1973) Range	Blower (1973) $\bar{x}$	Demarchi et al. (1982) Range	Demarchi et al. (1982) $\bar{x}$
Moderate to High	3	15-23	19	6-11	8.5
Low to Moderate	4	8-15	11.5	1-5	3
Very Low	5+6	1-8	4.5	< 1	<1
Altered	-	-		-	-

POOR

QUALITY

ORIGINAL